Acerca de este libro

Esta es una copia digital de un libro que, durante generaciones, se ha conservado en las estanterías de una biblioteca, hasta que Google ha decidido escanearlo como parte de un proyecto que pretende que sea posible descubrir en línea libros de todo el mundo.

Ha sobrevivido tantos años como para que los derechos de autor hayan expirado y el libro pase a ser de dominio público. El que un libro sea de dominio público significa que nunca ha estado protegido por derechos de autor, o bien que el período legal de estos derechos ya ha expirado. Es posible que una misma obra sea de dominio público en unos países y, sin embargo, no lo sea en otros. Los libros de dominio público son nuestras puertas hacia el pasado, suponen un patrimonio histórico, cultural y de conocimientos que, a menudo, resulta difícil de descubrir.

Todas las anotaciones, marcas y otras señales en los márgenes que estén presentes en el volumen original aparecerán también en este archivo como testimonio del largo viaje que el libro ha recorrido desde el editor hasta la biblioteca y, finalmente, hasta usted.

Normas de uso

Google se enorgullece de poder colaborar con distintas bibliotecas para digitalizar los materiales de dominio público a fin de hacerlos accesibles a todo el mundo. Los libros de dominio público son patrimonio de todos, nosotros somos sus humildes guardianes. No obstante, se trata de un trabajo caro. Por este motivo, y para poder ofrecer este recurso, hemos tomado medidas para evitar que se produzca un abuso por parte de terceros con fines comerciales, y hemos incluido restricciones técnicas sobre las solicitudes automatizadas.

Asimismo, le pedimos que:

+ *Haga un uso exclusivamente no comercial de estos archivos* Hemos diseñado la Búsqueda de libros de Google para el uso de particulares; como tal, le pedimos que utilice estos archivos con fines personales, y no comerciales.

+ *No envíe solicitudes automatizadas* Por favor, no envíe solicitudes automatizadas de ningún tipo al sistema de Google. Si está llevando a cabo una investigación sobre traducción automática, reconocimiento óptico de caracteres u otros campos para los que resulte útil disfrutar de acceso a una gran cantidad de texto, por favor, envíenos un mensaje. Fomentamos el uso de materiales de dominio público con estos propósitos y seguro que podremos ayudarle.

+ *Conserve la atribución* La filigrana de Google que verá en todos los archivos es fundamental para informar a los usuarios sobre este proyecto y ayudarles a encontrar materiales adicionales en la Búsqueda de libros de Google. Por favor, no la elimine.

+ *Manténgase siempre dentro de la legalidad* Sea cual sea el uso que haga de estos materiales, recuerde que es responsable de asegurarse de que todo lo que hace es legal. No dé por sentado que, por el hecho de que una obra se considere de dominio público para los usuarios de los Estados Unidos, lo será también para los usuarios de otros países. La legislación sobre derechos de autor varía de un país a otro, y no podemos facilitar información sobre si está permitido un uso específico de algún libro. Por favor, no suponga que la aparición de un libro en nuestro programa significa que se puede utilizar de igual manera en todo el mundo. La responsabilidad ante la infracción de los derechos de autor puede ser muy grave.

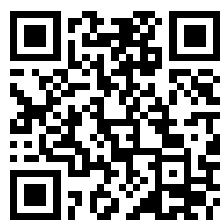
Acerca de la Búsqueda de libros de Google

El objetivo de Google consiste en organizar información procedente de todo el mundo y hacerla accesible y útil de forma universal. El programa de Búsqueda de libros de Google ayuda a los lectores a descubrir los libros de todo el mundo a la vez que ayuda a autores y editores a llegar a nuevas audiencias. Podrá realizar búsquedas en el texto completo de este libro en la web, en la página `http://books.google.com`

This is a reproduction of a library book that was digitized by Google as part of an ongoing effort to preserve the information in books and make it universally accessible.

Google™ books

https://books.google.com



5061
B 668,262 DUPL
AS
42.
.R88
v.12

Digitized by Google

Digitized by Google

F AS1
41
R88

TRANSACTIONS

AUG 20 1919

OF THE

Royal Canadian Institute

No. 27 MAY, 1919. Vol. XII, Part 1

PRICE $2.00

UNIVERSITY OF TORONTO PRESS

Digitized by Google

CONTENTS

The Reign of Law 1
J. Murray Clark, LL.B., K.C.

The Northern Interior of British Columbia and Its Maps (Plate I.) 25
Rev. A. G. Morice, O.M.I., M.A.

Educational Reform; Its Relation to a Solution of the Industrial Deadlock 41
C. V. Corless, M.Sc. (McGill).

The Growth of the Scales in Fishes 61
A. G. Huntsman, B.A., M.B.

Intellectual Consequences of the War 103
Franklin H. Giddings, Ph.D., LL.D.

Industrial Research 117
F. B. Jewett, Ph.D.

Digitized by Google

TRANSACTIONS
OF
THE ROYAL CANADIAN INSTITUTE.

THE REIGN OF LAW.

By J. Murray Clark, K.C.,
President of the Royal Canadian Institute.

(*November 3rd*, 1917.)

Permit me first to express my appreciation of the honour conferred on me by electing me President of the Royal Canadian Institute.

I regret very sincerely that my predecessor, Dr. J. C. McLennan, was unable to continue his work as President for another year. We expected, however, to have his co-operation and assistance during the present session, but the British Admiralty has arranged with the University of Toronto authorities for leave of absence for him during the coming year so that he may continue his very important work in Great Britain.

It is gratifying that the work of Dr. McLennan and other Canadian men of science is being increasingly recognized as contributing materially to the success of the Allies. The details of much of this work cannot yet be published, but we can safely say that the scientific achievements of Canadians have saved the lives of many of our soldiers and sailors, and will add to the lustre shed upon Canada by the glorious deeds of our fighting men. Dr. McLennan has refused the offer of Sheffield University, and we all wish him a safe return to his life-work for the advancement of science and for the permanent prosperity of Canada.

It is to be noted that two of the Ex-Presidents of the Institute have lost sons in the great war. I refer to Lieut. F. G. Stupart, 81st Bn., C.E.F., son of Sir Frederic Stupart, President in 1906-07, 1907-08, and Capt. W. V. van der Smissen, son of Professor W. H. van der Smissen, President in 1886-87, 1887-88. "Lost" is scarcely the word to describe such noble deaths, which we must see were not in vain.

At Vimy Ridge fell Second Lieut. F. K. Lefroy, R.F.A., son of Professor A. H. F. Lefroy, a very distinguished member of the University staff, and the author of several works, one of which, describing the Federal System in Canada, is at the moment being carefully studied by

Digitized by Google

the Irish Convention. Lieut. Lefroy was a grandson of General Sir John Henry Lefroy, R.A., F.R.S., one of the founders of the Institute, and President during the year 1852-53. The work of Sir John Henry Lefroy was very important, and had far reaching results. He was one of a very brilliant group who might describe themselves as:

"We few, we happy few, we band of brothers",

who had a great deal to do with moulding the Institute, and, through the Institute, the intellectual life of Canada. It is to be remembered that one of this group, Sir Sandford Fleming, at the time of his death Honorary President of the Institute, originated the plan of standard time which the Institute was instrumental in having generally adopted, so that in a very real sense Sir Sandford Fleming has left his "footprints on the sands of time".

The Institute has always been a staunch advocate of scientific research and of the application of science to industry. Before the war the Institute decided to establish a Bureau of Industrial and Scientific Research. The plans for the establishment of such a Bureau, carefully matured, have been approved by the Canadian Manufacturers Association, the Board of Trade of the City of Toronto, the Ontario Associated Boards of Trade, the University of Toronto, the Joint Committee of Technical Organizations, Ontario Branch Society of Chemical Industry, the American Institute of Electrical Engineers, Toronto Branch, and all the Banks having their head office in Toronto.

The movement acquired such momentum, and public opinion was so aroused, that the Dominion Government constituted an Honorary Council of Industrial and Scientific Research. While this Council has not yet been adequately supported, considerable progress has already been made. Under the direction of Professor A. B. Macallum, formerly President of the Royal Canadian Institute, the foundations are being solidly laid. Scholarships and Fellowships have been established so that researchers may be trained and the scientific spirit fostered.

Through the wisely directed munificence of one of our Life Members, Col. A. E. Gooderham, the Connaught Laboratories have been established and handed over to the University of Toronto and endowed by the Ontario Government. These Laboratories, which will be partially devoted to medical research, have already proved their usefulness, and will be of permanent service to science and to humanity.

The resolution passed this evening indicates the appreciation on the part of the Institute of this provision for medical research.

These things, however, and others that could be mentioned, are only small beginnings, and as yet only a few of our public men realize the truth of the statement of a profound thinker, that "Original research is

Digitized by Google

in itself the most powerful weapon that has been or ever can be wielded by mankind in struggling with the great problems which nature offers on all sides for solution." It would be a great pity if, through national short-sightedness, the centre of scientific research should pass outside the British Empire, a contingency of which the President of the Royal Society of Canada warned us that there was grave danger.

A Royal Commission, appointed in 1870, and presided over by the Duke of Devonshire (the seventh duke), recommended the establishment of a Council and Minister of Science; but action was, to the deplorable loss of Great Britain, postponed until after the war, when a Council was constituted by the Imperial Government, followed by the appointment of a similar Council in Canada to which I have referred.

While in the United States tens of millions have been appropriated by Congress to solve scientific problems, in addition to immense endowments by individuals and large expenditures by private companies, the Imperial Parliament voted five millions to promote research, and the total vote by the Dominion Parliament to the Honorary Council of Industrial and Scientific Research was a little over $90,000.

In his able address to the Institute last session, Professor C. A. Zavitz showed that, as a direct result of the scientific work of the Ontario Agricultural College, there had been an increase of several millions of dollars in the crop production of Ontario, that is, over what it otherwise would have been. The actual results prove that the application of science to improve the yield of barley (to give only one instance in the past fifteen years) has already brought to the Province a sufficient sum of money to maintain the Ontario Agricultural College for 190 years.

The other day I noticed an estimate that after the war the total of the Canadian debts, federal, provincial and municipal, would exceed five billion dollars, five times the staggering amount imposed on France by Bismarck after the Franco-Prussian War. The amount to be paid by us is, therefore, thirty-five times per capita the amount which the Germans thought would bleed France white. To enable us to pay the interest on these immense debts, such instances as I have mentioned of the application of science to industry must be multiplied, production must be increased, and waste eliminated.

We have many water-powers, the kinetic energy of which now goes to waste. British scientists showed us years ago how by the electrical production of nitrates from the air, this precious kinetic energy now wasted, could be converted into wheat. The Germans appropriated these British inventions, not only to increase food production, but also to manufacture explosives, but we in Canada have so far taken no advantage of them.

Digitized by Google

The United States will soon be a self-contained nation as far as compounds of nitrogen for fertilizer and explosive purposes are concerned. Will Canada wake up before it is too late? Will the neglect of science continue, and the forces of obscurantism prevail?

My humble opinion is that when we begin to feel keenly (as soon we surely shall) the pressure of the burden of our public debts for war and other purposes, there will be a sharp awakening, and Canadians will shake off the prevailing lethargy and apathy in regard to the application of science to industry. When we develop our enormous resources scientifically, we shall enter upon a new era of progress and prosperity.

Before the war, the attitude of the public was largely that of the mob who shouted when they killed the famous French scientist Lavoisier, "The Republic has no need of chemists;" and even since the war, have not some said, "Let us close the University"?—a University that has produced such men as McLennan, Mitchell, Nasmith, McCurdy and McLeod, and many others whose scientific work for the Allies will be recognized as invaluable!

The increasing pressure of the debts I have referred to, and the serious shortage of food, which, unless drastic action is promptly taken, will be much more serious in 1918, are beginning to make us realize that we must pay more heed to the scientists.

While the public are beginning to realize the benefit of practical results such as I have referred to, it is to be carefully borne in mind that most of the important scientific discoveries have been made in the pursuit of what is called pure science. Many examples of this can be given. Time will only permit me to refer to one, namely, the incandescent light. While many were endeavouring to solve this problem, on account of the keen competition of electric light, those who attacked the problem directly all failed, and this important industry was due to a discovery made by a scientist in investigating, for purely scientific purposes, the properties of oxides of rare metals.

While we emphasize the importance of industrial and scientific research, I am not of those who advocate that all education should be devoted to science, for we must ever bear in mind that there are things in heaven and earth not dreamt of in the philosophy of the materialist.

Rayleigh has well said: "In his heart he [the scientific worker] knows that underneath the theories which he constructs there lie contradictions which he cannot reconcile; the higher mysteries of being, if penetrable at all by the human intelligence, require other weapons than those of experiment and calculation".

Digitized by Google

It would, in my humble opinion, be a great mistake not to give due attention to the study of what are called the humanities. At the commencement of the great struggle in which we are now engaged, the call of Demosthenes was a potent one. The Allies are fighting to uphold international law, and Sir Henry Maine, with clear insight, long ago pointed out that no student without studying Roman Law can really know international law, on the vindication of which the future of the human race depends, because it alone protects the commonwealth of the nations from permanent anarchy.

In his famous message, President Wilson said that the world must be made safe for democracy. One of the most acute of the after-the-war problems undoubtedly will be to make the democracies safe from demagogues, and no one who has studied Thucydides and Aristophanes is likely to be deceived by demagogues. Take, for instance, the description of Cleon the Demagogue: "Of extraordinary impudence and little courage, slow in the field but forward and noisy in the assembly, corrupt but boastful of integrity and supported by a coarse and ready eloquence, he gained such consideration by flattery" that he achieved power.

Some of us remember a candidate who made himself invincible by declaring in stentorian tones that he would in all public actions follow the "*vox populi* of the people". He would not deceive anyone with even a little Latin.

I would not say that no one should be heard on public questions who is not a classical scholar. The public man across the border may have exhibited statesmanship as well as "horse-sense" when he advised his countrymen in circumstances of stress and agitation, that they could do more real good by "raising hogs" than by "raising hell", though his advice was not clothed in classical language.

Unfortunately, there are many who find it much more congenial and profitable to do the latter rather than do anything that is helpful.

In his recent profoundly thoughtful article on "The Real Basis of Democracy", Edmond Holmes truly wrote: "It is possible for the machinery of democratic organization to have been ingeniously contrived and to work smoothly and effectively, and yet for its chief function to be that of enabling ambitious and unscrupulous demagogues—true descendants of the robber knights of the middle ages—to exploit the people in the sacred name of democracy for their own selfish ends".

THE REIGN OF LAW.

With your permission I propose to make a few remarks upon the "Reign of Law". When the issues of the controversy with Germany are analysed, it may be said that it is for the supremacy of law that the

Digitized by Google

conflict is being waged. There is not time to give a complete history of the development of the German lawlessness. The root of the trouble may, however, be found in the statement of Bismarck that "Where the power of Prussia is concerned, I know no law". This was the foundation of the German doctrine that might is right, and led logically to the development of Prussian militarism, which must be finally and forever destroyed if the peace of the world is to be assured. To those who were able to read the signs of the times, what is known as the Zabern incident shed a lurid light upon the development of the German menace. The German doctrine that the state was supreme and bound by no moral obligation was gradually developed. Nietzsche said morality was the idiosyncracy of the decadent. The German poet Felix Dahn sang: "Since then it is the joyous German right, to win land with the hammer, we are of the Hammer-God's race and mean to inherit his world empire."

In his story of "Bertran and Bimi," written about the end of last century, Kipling makes Hans Breitmann say to Bimi, the orang-outang who murdered Bertran's wife: "You haf too much Ego in your Cosmos". That vividly states the trouble with the Germans in 1914, and though the war has yet to be won, I do not think there is as much ego in the German cosmos as when they began the war, and they now rely on such agencies as the Socialists, I.W.W., and similar organizations. If all the Allies would act as vigorously and energetically against these agencies and the German propaganda as the United States, hundreds of thousands of lives would be saved.

By means which it is not necessary to detail further, the German people were so indoctrinated with this idea that the military caste in Germany thought it opportune to bring on the present war, for which the representatives of the German people almost unanimously voted funds.

That the German people had not become completely demoralized before the commencement of the war is indicated by the circumstance that the German Chancellor admitted that the violation of the treaty he had termed a "scrap of paper" was wrong. His words to the Reichstag on August 4, 1914, were:

"The wrong—I speak openly—that we are committing we will endeavour to make good as soon as our military goal has been reached."

At that time even he had not yet lost all sense of the distinction between right and wrong. The initial success in Belgium completed the diabolic work of Nietzsche, Treitschke, and Bernhardi, and of the misguided German theologians, and the German people almost unanimously approved of the German war policy. The Kaiser declared there was no international law. The Germans, having jettisoned the laws of God and

Digitized by Google

man, considered themselves free for any frightfulness which they thought would advance the interests of the German State. Hence logically followed the atrocities in Belgium, Poland, and Servia, and the massacre of the Armenians, and it is to be remembered that when the Turks refused to turn their guns on a group of Armenian women and children, the Germans had no compunction, and proceeded to murder them without hesitation, so that they could not interfere with their future plans.

Hence logically followed the poison gas, the poisoning of wells by the Germans, the sending of anthrax and other germs by diplomatic couriers to Roumania, and other abominations which we are too apt to forget. Whatever else may be forgotten and overlooked, if international law is to be vindicated and the future of humanity safeguarded, those responsible for the murder of Edith Cavell and Captain Fryatt, and for the murder of the women and children drowned when the Lusitania was illegally sunk must be punished. These were all blunders as well as crimes. Blinded though the Germans are by a false philosophy, (for not only in Europe, but in Canada, the United States, and even as far away as Honolulu, Germans rejoiced in the sinking of the Lusitania); they will soon perceive how stupid were their blunders when a million soldiers from the United States appear in France determined to give as good an account of themselves as the Canadians who barred the way to Calais and took Vimy Ridge, and whose heroic deeds in France and Flanders will gloriously live in history as long as liberty shall endure.

The criminal course of Germany as a State must react upon all its citizens who do not protest and resist, and must result in their moral deterioration. One is therefore not surprised to learn that the German Crown Prince, his officers and men, have been stealing in northern France for their private benefit—as common thieves and vulgar robbers—not for the Fatherland, but for their degraded selves.

Nemesis is inexorable, and it may be anticipated that the German people will later rend the Kaiser, Crown Prince, and the whole vile breed of Hohenzollerns, with the same brutality and cruelty the German soldiers have been taught to practice on the Poles, Belgians, and others. In the nature of things that is not likely to take place so long as the Germans can win such victories as they achieved last year against the Rumanians, and this year against the Russians and Italians. Nor indeed until the armies of the Central Powers are completely defeated, and the German people know by the presence of victorious Allied soldiers in German territory that they have been wickedly deceived. The Germans approved of the horrible atrocities perpetrated in Belgium and called it "a joyous war", "der fröhliche Krieg"—the German word looks like "frolic".

Digitized by Google

Since the decisive battle of the Marne, the joy has departed, and the enemy now hope for a German peace which will enable them to prepare for the next war. Lloyd George has declared with authority there will be no next time, and so the issue is joined, and in this fateful hour of the world's destiny, Canada and Russia are preparing for elections.

A despatch the other day read: "'Rather death than slavery' is the clarion note sounded in the National Press to-day in the face of the new barbarian invasion of Italy. In political speeches there is a tendency to sink the partisan dissensions and dilly-dallying which recently afforded so sorry a spectacle during the parliamentary discussion".

There was a similar sorry spectacle in the Canadian Parliament, but whatever history may say of our politicians, there are certainly no partisan dissensions or dilly-dallying among the Canadian soldiers fighting in stern reality against lawlessness, and for the establishment of the reign of law in the civilized world.

What, you may ask, are the prospects of the reign of law in Russia? The real cause of the troubles in Russia which are having such disastrous results, is the spirit of lawlessness, or, as a member of the Russian Government termed it, anarchy.

Many of the soldiers and sailors, after the Czar had gone, still shouted, "Down with authority!" The universality of the genius of Shakespeare is shown by the words he used three hundred years ago, which vividly describe the consequences, if this is accomplished:

> And, hark, what discord follows! each thing meets
> In mere oppugnancy: the bounded waters
> Should lift their bosoms higher than the shores,
> And make a sop of all this solid globe:
> Strength should be lord of imbecility,
> And the rude son should strike his father dead:
> Force should be right; or rather, right and wrong,
> Between whose endless jar justice resides,
> Should lose their names, and so should justice too.
> Then everything includes itself in power,
> Power into will, will into appetite;
> And appetite, an universal wolf,
> So doubly seconded with will and power,
> Must make perforce an universal prey,
> And last eat up himself.

Kerensky, the Russian Prime Minister, thoroughly understood this, and stated that Russia would be ruined unless discipline in the army was maintained. On one occasion the mob were intent on murdering one of the Russian generals against whom certain allegations were made.

Digitized by Google

Kerensky, at the risk of his own life, stood between the general and the furious mob, and said that the general must be tried according to law. This demonstrates that Kerensky had the root of the matter in him, as no doubt have many of his fellow countrymen; and we may, therefore, confidently predict the ultimate establishment in Russia, after a long and painful struggle, of liberty based on law. As Elihu Root, the great American statesman who visited Russia as the representative of the United States, pointed out, the organizations which have demoralized Russia are similar to those which have caused so much mischief in the United States, and, I may add, in Canada also.

We can realize the tremendous difficulties in Russia by recalling the initial successsses of the German propaganda on this continent. Not many months have elapsed since that song of degradation, "I didn't raise my boy to be a soldier," was enthusiastically sung by dupes of the German agents.

Much mischief is still being done both in the United States and Canada by this pernicious propaganda, the purpose of which is to prevent the sending of reinforcements and supplies to Europe and to prevent the increase of production necessary to the success of the Allies.

The English-speaking people should therefore not judge the Russians too harshly. In 1667, owing to the corruption of the British Government, an enemy fleet sailed up the Thames. This was more than 450 years after Magna Charta, and over 50 years after the warning of Shakespeare in King John:

> "This England never did, nor never shall,
> Lie at the proud foot of a conqueror,
> But when it first did help to wound itself".

Nearly a hundred years after this the plans of the great Pitt were defeated by venal acts in the British Parliament. We read that 316 members voted for the Peace. Sixty-five on the other side, said Walpole, "were not bribed".

Historically there is too much foundation for the fear frequently expressed that "that which the soldiers and sailors will win the politicians will give away."

It will require a tremendous effort to bring any kind of order out of the deplorable chaos in Russia, and whether, after fighting the enemies of law and the German agents within, there will be any surplus energy to drive out the German army from the occupied Russian territory remains to be seen.

Wordsworth, with profound statesmanship, truly said:

> "We must be free or die, who speak the tongue,
> That Shakspeare spake; the faith and morals hold,
> Which Milton held."

Digitized by Google

This freedom for which the English-speaking world is now unitedly fighting is based on the unquestionable supremacy of the civil power, and the universal rule of equal law. We are apt to regard the universal rule of equal law as a matter of course; but it is the result of a long struggle and can be maintained only by constant vigilance and effort.

Scientists tell us that there is always a danger of reversion to inferior types. So in matters of government, there is constant danger of the usurpation of arbitrary power, and against this Kipling uttered a timely warning when, in his poem on "The Old Issue", he said:

* * * * * * *

All we have of freedom, all we use or know—
This our fathers bought for us long and long ago.

Ancient right unnoticed as the breath we draw—
Leave to live by no man's leave, underneath the law.

Lance and torch and tumult, steel and grey-goose wing,
Wrenched it, inch and ell and all, slowly from the king.

* * * * * * *

So they bought us freedom—not at little cost—
Wherefore must we watch the King, lest our gain be lost.

* * * * * * *

Howso' great their clamour, whatsoe'er their claim,
Suffer not the old King under any name!

Here is naught unproven—here is naught to learn.
It is written what shall fall if the King return.

He shall mark our goings, question whence we came,
Set his guards about us, as in freedom's name.

* * * * * * *

He shall break his Judges if they cross his word;
He shall rule above the Law, calling on the Lord.

He shall peep and mutter; and the night shall bring
Watchers 'neath our window, lest we mock the King—

* * * * * * *

Strangers of his council, hirelings of his pay,
These shall deal out Justice: sell—deny—delay.

* * * * * * *

Cruel in the shadow, crafty in the sun,
Far beyond his borders shall his teaching run.

Digitized by Google

Sloven, sullen, savage, secret, uncontrolled—
Laying on a new land evil of the old;

Long-forgotten bondage, dwarfing heart and brain,—
All our fathers died to loose he shall bind again.
* * * * * * *
All the rights they promise—all the wrong they bring.
Stewards of the Judgment, suffer not this King!
* * * * * * *

One of the crowning features of the British system under which we in Canada live is the final authority, in matters of law, of the Judicial Committee of the Privy Council, or, to speak more accurately, of the King speaking on the advice of the Judicial Committee of the Privy Council.

So far as the Province of Ontario is concerned, this is founded on a statute passed by the first Parliament of Upper Canada, held at Niagara, in 1792, which enacted that we should be governed by the laws of England, and that there should be an appeal to the King in council. This statute has been re-enacted from time to time, and is still in force.

According to Blackstone, under the British Constitution the King is the fountain of justice and the general conservator of the peace of the empire. By the fountain of justice the law does not mean the author or original, but the distributor. Justice is not derived from the King as his free gift, but he is the steward of the public to dispense it to whom it is due. Blackstone quotes Bracton for the proposition that for this very purpose was the king created and elected, in order that he might render justice to all. *Ad hoc autem creatus et electus ut justitiam faciat universis.*

In the early days of arbitrary power, monarchs sometimes decided cases personally, but it has long been settled that justice must be distributed through the regular courts. The last attempt to evade this salutary rule was that of James I, in the celebrated case of Evocation, when Coke stoutly replied to the monarch that he could only in such matters speak through his courts (*per curiam*), observing that the law was the golden metwand and measure to try the causes of subjects. In the following reign of Charles I (1641), it was enacted that all questions of property, etc., "ought to be tried and determined in the ordinary courts of justice and by the ordinary courts of law".

There is no more danger of monarchical tyranny in Canada than in any other part of this continent, nor, indeed, so long as the British navy is strong enough to protect the liberties of Europe and the security of America, of the divine right of the Kaiser. When recently (to adopt

Digitized by Google

the classical language of Lincoln) the British people decided to dedicate themselves more fully to the great task remaining before us, and that from the honoured dead of the Allies who had given to the cause of humanity the last full measure of devotion, we should all take increased devotion to that sacred cause, and to this end highly resolved that those dead shall not have died in vain, and that Europe, under God, should have a new birth of freedom and that the government of the people, by the people, and for the people shall not perish from the earth, as it would if Prussian militarism or its ally Socialism triumphed; and when it was decided in form by their leaders, but in reality (whether rightly or wrongly remains to be proved) by the British people that these lofty purposes would be more speedily achieved under Lloyd George than under Asquith, there was no difficulty in promptly carrying out the necessary change. Indeed, the fact that such a change as that from Asquith to Lloyd George would be impossible in the United States before the presidential election of 1920 (apart from impeachment), demonstrates that the British system is more elastic and responsive to the popular will than the United States system.

At one time some thought there was danger that the United States would be brought under the influence of German *Kultur*. As long ago as 1899, John Hay perceived the hatching of the German intrigue against the United States, and warned President McKinley, and afterwards President Roosevelt, though, as Thayer in his "Life of John Hay" says, "Only after the German Kaiser had forced his atrocious war upon the world in 1914, did his agents in the United States proclaim that they had built up an organization so powerful that it would compel the American government to do their bidding, which was his". At present there is no sign of the American Government doing the bidding of the Kaiser or his agents.

General Bernhardi, who advocated the present war, predicted as the result world dominion for the Germans, or their downfall. The danger of such world dominion may be said to have been warded off by the victory of the Marne. And, by the way, when we reflect on what the French so gloriously did in winning the battle of the Marne, and in holding Verdun, we surely should hear no further talk of the decadence of Latin civilization, to which humanity owes so much, including the Roman Law. That system still governs a large part of the human race, not by reason of imperial power, but by the imperial power of reason, if we may so paraphrase the famous saying of Portalis, "*non ratione imperii, sed imperio rationis*".

There is, fortunately, another alternative besides those stated by Bernhardi—world dominion or downfall—namely, the reign of law.

Digitized by Google

This is clearly brought out in the historical reply of the Allies to President Wilson. The Allies require, not the annihilation of Germany, but complete reparation, adequate guarantees, which surely must include the just punishment of those personally responsible for such crimes as I have referred to, and the maintenance of the public law of Europe, protecting each of the nations, great and small, in its right to life, liberty and the pursuit of happiness, each developing its own culture according to its own genius. Even Germans should be permitted to develop their own *Kultur*, provided they are not permitted to impose it by force on others.

There are, however, other dangers to our liberties to which citizens of the United States and Canada are both exposed, and which threaten what Chief Justice Fuller aptly called an enduring government of laws, not of men. Largely as a result of the violation of the fundamental principles of government, and of disregard of the warnings of Lincoln, who understood these principles very thoroughly, it has come about that, practically, amounts varying from 30 to 60 per cent. of taxes collected in both countries are wasted. In Canada we designate the main cause of this waste as "patronage". Ex-President Taft told us in Toronto that the phrase used in the United States was "pork-barrel appropriations". In each case, on analysis, this means buying the votes of the people with their own money, or rather the votes of some of the people with the money of the others.

Some have looked with longing eyes at the much-heralded efficiency of German bureaucracy. But this is a case of distant fields looking green. One of the influential German journalists recently advocated the introduction of what he called the American custom of lynching as the most expeditious method of getting rid of the oppression of German bureaucrats. This, by the way, and the advocacy by Germans of the deposition of the Kaiser, I regard as the first authentic signs of the beginning of the end of the Prussian military caste and of the war.

Others have advocated the adoption of the initiative, the referendum, and the recall, which all strike at the fundamental principles of representative government. They are indeed futile attempts to evade the consequences of disregarding the ancient admonition that we should choose as administrators (including legislators) able men who fear God and hate covetousness.

Not by such devices, nor indeed by any means, are these consequences of incompetence, inefficiency, and dishonesty, evitable. They are all pernicious, but especially the recall of judges which involves a denial of justice, and justice was truly described by Alexander Hamilton as the end of government. Indeed, it always seems to me to be tanta-

Digitized by Google

mount to expressing approval of the mob who cried "Crucify Him", and "Not this Man, but Barabbas", who "was a robber". The clamour of the mob was not the voice of justice, nor yet the true voice of democracy. We cannot too strongly emphasize the warning of Burke, who, after a profound study of the fundamental conditions of free institutions, said: "Liberty to be enjoyed must be limited by law: for where law ends there tyranny begins: and the tyranny is the same, be it the tyranny of a monarch or of a multitude; nay, the tyranny of the multitude may be the greater, since it is multiplied tyranny".

The two institutions undoubtedly most influential in upholding the supremacy of law, which is the fundamental condition of true liberty, are the Supreme Court of the United States and the Judicial Committee of the Privy Council. Both have jurisdiction over states and provinces, each sovereign within the sphere of its own authority. Surely the successful and satisfactory exercise of this jurisdiction contains the promise and potency of a supreme court of the civilized world, which shall bring the future of humanity under the "majesty of the law", to quote the eloquent phrase of the distinguished French statesman, Bourgeois.

Time is not available to trace the intensely interesting history of the jurisdiction of the Judicial Committee of the Privy Council. It must suffice to say that it was established in its present form in 1833, by an act introduced by Brougham, one of the greatest of law reformers. This act has been, from time to time, amended by subsequent statutes, including the Appellate Jurisdiction Act of 1913, which provided for two additional judges. The only one of these amendments that need be further referred to is that passed in 1895, authorising the addition of five members of the Judicial Committee from Canada, Australia, South Africa and other parts of the British Dominions. These five must be or have been judges of certain specified Canadian, Australian, or South African courts, or of some other superior court in His Majesty's dominions, to be named by competent authority, and must be members of the Imperial Privy Council.

The Judicial Committee is to be distinguished from the House of Lords, and by the House of Lords in this connection I mean the judicial body and not the legislative body of the same name which earned the gratitude, not merely of the British Empire but also of all friends of civilization, by rejecting the so-called Declaration of London. If this declaration had become law, it would have seriously handicapped the British navy, certainly in this war the bulwark of liberty, and would have been a potent factor in favour of Prussian militarism. Fortunately, owing to its wise rejection by the House of Lords, a co-ordinate part of the British Parliament, it did not become law, and never became

Digitized by Google

binding upon Great Britain. To allege, as some who should know better erroneously do, that Great Britain, which is fighting for the vindication and maintenance of international law, violated the Declaration of London, is therefore the sheerest nonsense.

The judicial body known as the House of Lords is composed of the same judges as sit in the Judicial Committee of the Privy Council, and has a jurisdiction defined by an imperial act passed in 1876. While the judges are largely the same, there are some important distinctions between these two tribunals.

While cases argued before the Judicial Committee of the Privy Council are really decided by the judges who hear them, the order issued is the order of the King made on their advice. Some important consequences follow from this. The Privy Council advises the Crown, and in doing so is bound not to record dissentient opinion. This was provided for in 1627, and the prohibition was reaffirmed in 1878. Only one set of reasons for judgment is given. One of the greatest living authorities on jurisprudence, Sir Frederick Pollock, states as the criteria of just laws in a civilized community "generality, equality, and certainty", and the rule which prevails in the Privy Council tends greatly to promote all these, but especially in the desirable quality of certainty. The House of Lords is bound by its own decisions in accordance with the rule laid down by Blackstone, that the duty of the judge is to abide by former precedents. This rule is not binding on the Judicial Committee of the Privy Council, which is required to decide in each instance according to the very right and justice of the particular case before it.

Some eminent jurists and statesmen have advocated a great Imperial Court of Appeal to take the place of the House of Lords and the Judicial Committee of the Privy Council. There are constitutional and other difficulties in the way, but the obvious advantages are so fundamental that it is to be hoped this beneficial reform will soon be accomplished.

The Lord Chancellor is a member of the Judicial Committee, and his position is a striking example of the English disregard of the doctrinaire division between the judicial, executive, and legislative powers, for the Lord Chancellor is head of the judiciary, a member of the cabinet or executive government, and also a member—indeed, the presiding officer—of the second chamber of the British Parliament.

Whatever may be the theoretical objections, no practical difficulties have arisen. In his brilliant book on "The Oppressed English", Ian Hay mentions the fact that the present Lord Chancellor of England is a Scotsman.

Over a quarter of a century ago a member of the firm of solicitors for the Bank of England remarked to the Attorney-General of Ontario,

Digitized by Google

then in one of the courts in London, England: "Do you see those three Scotsmen? Every one of them will become Lord Chancellor of England". The first of the three counsel then in court to become Lord Chancellor was Lord Loreburn, the second Lord Haldane, and the third was Lord Finlay, who last December became the Lord Chancellor of the Lloyd George government. It is fortunate that at the present juncture the highest British appellate court is presided over by one in whose fairness, impartiality, and accurate knowledge of international law there is such complete confidence.

Time would not permit me to give an adequate account of the invaluable services to the United States of the Supreme Court, or of the similar services rendered to Canada and the other parts of the British Empire by the Judicial Committee of the Privy Council. In Canada there were angry disputes between provinces of different races and diverse creeds, and it was most fortunate that there existed such a tribunal as the Judicial Committee of the Privy Council to decide such disputes as they did, and to do it so satisfactorily.

The Supreme Court of the United States has rendered notable services, not only to the United States, not only to jurisprudence and international law, but also to the cause of civilization. The fame of its great jurists, of whom I shall mention only Marshall, Story and Brewer, extends far beyond the boundaries of the United States; indeed, whereever the gladsome light of jurisprudence illumines the path of progress.

I have referred to the courts. What about legislation? Have we not omnipotent parliaments representing the sovereign people who can, if they would, speedily remedy all the ills that flesh is heir to. The irrepressible faith in the efficacy of legislation and in the promises of politicians is one of the marvels of the ages, and we are ever prone to forget

> "How small of all that human hearts endure
> That part which laws or kings can cause or cure".

Perhaps I can best illustrate the limited sphere in which legislatures can effectively or usefully interfere by a concrete example.

Some politicians concluded that mathematicians represented the ratio between the circumference and diameter of a circle in an accurate manner that was unnecessarily troublesome, and passed a statute that this ratio should be 3.15. Why should the children of the free and independent electors be bound by the calculations of Archimedes thousands of years ago, or by the fact that a certain French mathematician, Lambert, demonstrated in 1766 that the ratio in question could not be a rational number, though his proof required the assistance of Legendre, which was subsequently given.

Digitized by Google

Not that the legislators actually said this. They were probably ignorant of the calculations of Archimedes and of the work of the French mathematicians I have referred to; or if they did say so, could they not answer, the French were a frivolous people?

When one reflects on the phenomenon, it is a curious thing that while we will not permit anyone to operate on the body of the humblest citizen without long and scientific training as a surgeon, we elect legislators to operate on the body politic without any scientific training, and without any adequate knowledge of social science, or even of the principles of legislation.

It is therefore very fortunate that the legislators I have referred to, or indeed any others, could not alter the ratio of the circumference to the diameter of a circle by the one billionth part of a unit, Even in Canada we now talk in billions, and shall soon have to learn in the school of experience to pay interest on billions, and in that hard school we shall learn much else.

Since Confederation, economy has been unpopular, and politicians could win more votes by squandering a million dollars than by saving a million dollars. I am quite certain that will not be the case five years from now.

Meantime we should note that the politicians could not set aside the conclusions of the ancient mathematicians any more than the so-called invincible German army was able to upset the calculations of a great modern French mathematician, General Pétain, at Verdun, and should ever bear in mind the wise words of Bacon: "For the chain of causes cannot by any force be loosed or broken, nor can nature be commanded except by being obeyed". It is because these principles have been neglected that so much of the legislation passed has been futile and mischievous, and the results disappointing.

In his "History of Civilisation", Buckle shows that statutes to decrease the rate of interest (which can always command a majority) have invariably resulted in increasing the rate of interest which the borrower has directly or indirectly to pay.

Legislation should be an important factor in progress, but to remedy the present unsatisfactory conditions we must begin at the very foundation. The problems to be solved are certainly, to use the apt words of Browning, "multiform, manifold, and menacing". Statecraft must call science to its aid; for such evils can only be cured by the removal of their causes.

The principles of ethical science and social service should be taught in the schools and universities, so that every citizen may thoroughly understand the rights and duties of citizenship, especially the duties.

Digitized by Google

Many people outside of Germany have too much Ego in their Cosmos.

If there were any general knowledge of the fundamental principles of political science, there would not be so much astonishment at the argument of a correspondent of the *Spectator*: that if the views of the so-called conscientious objector are carried to their logical conclusion, he should be regarded as an outlaw. The duty to protect the State is correlative to the right to protection by the State of person and property. To be consistent, the opponent of compulsory service which we call conscription must say, "Who steals my purse steals trash", that if his valuables are taken, no violence, even of the police, will be used in his favour, and that he will rely exclusively on moral and spiritual forces for the protection of his person and his property.

The present methods of electing representatives to legislatures and parliaments are crude and unscientific. Sir Sandford Fleming, though he lived in Ottawa, was optimistic enough to think what he called the rectification of parliament was possible. Sir Sandford was a great engineer, and all really great engineers are optimists. Sir Sandford was right; for Proportional Representation is not only right in theory, but quite feasible in practice.

The present crude system of electing members of parliament gives undue influence to the "grafters", and to those who make money out of politics; and the soldiers on the various fronts who have been grappling with stern realities are likely to insist on the speedy rectification of parliament, which can only be achieved by a scientific plan of proportional representation and selection.

INTERNATIONAL LAW.

I desire to preface my remarks on International Law by a letter written by me in March last. It was addressed thus:

Kent Building, Toronto, Canada,

March 26th, 1917.

The Secretary,
Carnegie Endowment for International Peace,
407 West 117th Street, New York City, N.Y., U.S.A.

Dear Sir:

Thanks for your reprint of the Cosmos letters, which I shall study carefully as soon as the Allies, now fighting for the cause of humanity, achieve complete victory over Germany and her dupes who seek to

Digitized by Google

destroy human liberty. No one who does not do all in his power to stop the massacre of the Armenians by the Turks (acting with the knowledge and consent of Germany), to prevent the Belgians being drafted into a slavery more horrible than that from which Lincoln freed your South, and to punish the murder of women and children and other non-combatants by the Germans, should be heard in discussing any peace either now or after peace is won.

The conditions of peace should be settled by those who make the sacrifices necessary to end the war. At present only those who assist in the fight against Germany to their utmost are entitled to the blessing assured to the peacemaker.

The United States took a prominent part in bringing about the Hague Convention, on which Belgium relied in vain, and therefore your citizens are under a special obligation to Belgium, which I am pleased to see is being recognized by an increasing number.

The position could hardly be better put than by one of your eminent citizens, Mr. Church, of Pittsburg, who said: "You will remember that Dante in the Inferno, found a hell beneath all other hells prepared for those timid beings who insisted on being neutral in the everlasting fight between good and evil. This War is a fight between those forces of good and evil."

Though the Kaiser blasphemously claims God as his junior partner, thereby making the Deity a party to his atrocious crimes, such as the murder of the women and children who were drowned when the Lusitania was illegally sunk, I still believe that God is a God of righteousness and justice. If so, it is certain that in the nature of things there can be no true peace until righteousness and justice are vindicated, and the last live German soldier driven from the soil of Belgium and France. Consequently, anyone who, knowing the atrocities being committed by the Germans in Belgium, France, and elsewhere, urges peace now, must be moved by the devil. The only alternative is that the advocate of peace must be inspired directly or indirectly by German gold.

I noticed that a member of the German Reichstag inquired as to results of the expenditure of large sums of money previously voted to further German plans in the United States, and was interested to read that the German conspiracy against the United States was perceived over a decade ago by one of your statesmen, the late John Hay, though I suppose the extent of this conspiracy did not become generally known until recently.

Let me add that I am not one of those who say pacifists are the cause of the War, and share with the Germans the guilt of all its bloodshed and horrors. Having studied history very closely and had the

Digitized by Google

special advantage of discussing the meaning of the German preparations with friends of insight and foresight, I warned our people that in the present conditions of the world there was always danger of sudden war, but would not even now censure those who before the War believed the plausible assurances of the Kaiser. It is, however, very clear now, that when the Germans proposed peace they intended war, for which they had feverishly prepared, and that the Central Powers now ask for peace in order to prepare for another war.

Those who assist in attempting to accomplish this, assume an awful responsibility for all the bloodshed and misery of such a second war. Certainly now, only those are entitled to be regarded as lovers of peace who are prepared to make real sacrifices to achieve it. I am proud to say, most Canadians, who above all are lovers of peace, are making such sacrifices, some, of their lives, in order to destroy Prussian militarism, so that we may bequeath to our children the blessings of permanent peace.

Yours very truly,

J. MURRAY CLARK.

In discussing the future of international law, it is necessary to be careful not to be misled by the ambiguity of the term *law*.

Experience tells us of the uniform succession of phenomena. Our consciousness postulates a causal nexus, to denote which the term *law* is used. In this sense *law*, like *substance* and *causality*, are conceptions inherent in the human intellect.

It is not in this sense the term *law* is used in discussing International Law. Holland, one of the greatest authorities on Jurisprudence, defines law as a general rule of external human action enforced by a sovereign political authority. In this strict sense there is, of course, no such thing as International Law, for the persons of International Law are states themselves sovereign. The only feasible method of finally terminating this sovereignty of states is by establishing "the parliament of man, the federation of the world". Such a parliament could only be on the democratic basis of universal suffrage. The hundreds of millions of Chinese would out-vote the English-speaking peoples, and, however highly we may regard these members of the brotherhood of man, we are certainly not yet prepared to trust our destinies in their hands.

Charles H. Pearson, the author of "National Life and Character," wrote, in 1893:

"It is now more than probable that our science, our civilization, our great and real advance in the practice of government are only bringing us nearer to the day when the lower races will predominate in the world,

Digitized by Google

when the higher races will lose their noblest elements, when we shall ask nothing from the day but to live, nor from the future but that we may not deteriorate."

If Pearson could read the history of the present war he would write differently.

What, then, is International Law? The best definition I know of is that given by Lord Russell of Killowen, Lord Chief Justice of England, in his address to the American Bar Association at Saratoga. He defined International Law as the "sum of the rules or usages which civilized states have agreed shall be binding on them in their dealings with one another". This definition has been adopted by the Court of Appeal in England. The basis of International Law is, therefore, an agreement or the rule of good faith.

There is now no external political authority that can command sovereign states, for it is a basic principle of International Law, as it at present exists, that each nation must be the "judge of its own quarrels and the executioner of its own decrees". Much mischief has been done and many false hopes raised by those who have failed to grasp the limited scope of International Law, which deals only with the relations between states. Its influence can only be extended by increasing respect for the rights of others, reverence for law and a determination to observe good faith. These, however, are important, nay, essential, to the very existence of civilization.

What, then, about the proposed League of Nations? It is certainly to be commended, provided we realise its limitations, and do not mistake dreams for realities, or permit a sense of false security to lure us into a fool's paradise. For it does not much extend the promise of peace among men of good will, and certainly does not provide adequate means of dealing with men and states not governed by good will. The sad experience of humanity shows that much reliance cannot be placed upon peace movements, the apparent success of which has always hitherto been followed by horrible war. It is, as Carlyle would say, significant of much that, while there was some warlike talk, there was, during the presidency of Theodore Roosevelt, profound peace in the United States, and that when there was in power in that great country a government composed largely of pacifists, the Germans sunk the *Lusitania*, murdered the citizens of the United States, including women and children, and, by declaring ruthless submarine destruction, forced the United States into the bloodiest war of all history.

The French Prime Minister defined the present position very precisely (as becomes a distinguished mathematician) as well as authoritatively during the present week when he said: "There is to be neither

Digitized by Google

halt nor parley until the German brute force is shattered and the world terror ended; momentary trials which are afflicting Italy, and against which the forces of the Allies will make headway successfully, may delay, but cannot modify the issue of this formidable war, which henceforth is inevitable. Germany may make other spectacular moves in the far off and temporarily indefensible areas, but we are delivering solid blows on the Western front. Whenever Germany is sincerely ready to consider peace it will be because she is beaten, and when she is beaten the victors will write the terms of peace in conformity with justice and the rights of humanity, steadfastly refusing to admit any compromise with violence." The reign of law admits no compromise with violence.

International Law is as yet law between states and supernational law has not yet been developed.

President Wilson says:

"We are at the beginning of an age in which it will be insisted that the same standards of conduct and of responsibility for wrong done shall be observed among nations and their governments that are observed among the individual citizens of civilized States."

Before this can be accomplished Prussian militarism and autocracy must be destroyed and right vindicated. But if this ideal is realized, it must be by supernational rather than by international law, that is there must be somebody to do the "insisting".

In a paper read before the Institute several years ago, I pointed out the analogous development of Roman Law in dealing with disputes between private individuals, and I need not repeat what I then said. Indeed, the analogy between international law and primitive law has often been pointed out.

Many of the Anglo-Celtic laws were largely hortatory rather than compulsory. The King exhorts rather than commands his subjects as good Christians to keep the peace and to conduct themselves properly.

It took a long time to establish the jurisdiction of our civil courts. Even as late as 1818, in the famous case of Ashforth v. Thornton (1818), 1 B. and Ald. 405, Lord Ellenborough, C.J., laid it down that the general mode of trial by law, in case of appeal, is by battle at the election of the appellee, unless the case be brought within certain exceptions not necessary to be here referred to. This mode of trial introduced in England by the Normans remained the law of the land until 1819, when it was abolished by 59 Geo. III, ch. 46.

The evolution of the State as the organ of social control, in place of groups of kindred or religious organizations, was gradual, but when we remember that in primitive society private law arose out of leagues or confederations of clans, may we not hope for analogous results from the

Digitized by Google

proposed league to enforce peace, and that the development of some reliable means of enforcing legal rules, including the rule of good faith (to which I have referred) among states, may be achieved? Certainly such a league among the English-speaking peoples, the peoples of the Great Charter of Liberty, would be a potent force for the preservation of the peace of the world.

General Jan Smuts can tell us something well worth considering on this subject. He is a very distinguished graduate of Cambridge, and some years ago, by his great ability and energy, earned our respect in a way, however, which would not have won him many votes in Toronto at the time. Recently his great services to the Empire, not only as a soldier, but also as a statesman, have entitled him to speak with considerable authority.

General Smuts said a short time ago:

"The only successful experiment in international government that has ever been made is the British Empire, founded on principles which appeal to the highest political ideals of mankind. . . . Our hope is that the basis may be so laid for the future that it may become an instrument of good, not only in the Empire, but in the whole world."

This vividly recalls the statement made many years ago, which cannot be too often quoted, that the British Empire is the greatest secular agency for good the world has ever known. The Imperial War Conference declared that "The readjustment of the constitutional relations of the component parts of the Empire is too important and intricate a subject to be dealt with during the war, and that it should form the subject of a special Imperial Conference to be summoned as soon as possible after the cessation of hostilities." The experience of the United States demonstrates that a federal union is the only permanent solution, but we must remember that a federation of the United States could not be achieved until a system of alliances such as now proposed for the British Empire had proved inadequate, and that South Africa adopted a union rather than a truly federal government. At the present time public opinion is not yet prepared for a truly Imperial Parliament to whom the Imperial Executive already constituted shall be accountable according to the well-tried principles of responsible and representative government.

Although the decisions of the momentous Conference, so arranged to be held, may affect the destinies of Canada, and indeed of over one-fifth of the human race, many amongst us have not yet seriously considered its far-reaching consequences.

Meantime, that a basis satisfactory to General Smuts has been laid by the genius of Lloyd George is shown by the following extract from

Digitized by Google

a remarkable article by Sidney Low in the August number of the *Nineteenth Century:*

"It may be, and we must all hope it will be, Mr. Lloyd George's good fortune to go down to history as 'the pilot that weathered the storm', the Prime Minister who brought Britain victoriously through the closing stages of the greatest war of all time. But whether or not he win that title to immortality, he has already done one thing which must give him a permanent place in the annals of our constructive statesmanship. Since he came into office in December last the development of a true Imperial constitution has gone forward by long strides. The process has been unobtrusive, and almost unnoticed amid the intense pre-occupations, the poignant suspense, the hopes, and fears, of the campaigns by sea and land. But when the ultimate account is made up and the balance struck, it may be found that the meetings of the Imperial War Cabinet and the Imperial War Conference are more important in their enduring results than the battles and the revolutions. For from them will arise the new integration of the British system of nations on which the peace of the world, and the ordered progress of humanity, so largely depend."

Let us hope that Canadians may be as worthily represented at this Conference as we are on the battlefields, for Canada is verily the keystone in the arch which we call the British Empire or Commonwealth, and upon the strength of that arch, upon the strength and permanence of that Commonwealth, rest our best hopes for the establishment of the reign of law, as the only sure guarantee of the peace of the world.

Digitized by Google

THE NORTHERN INTERIOR OF BRITISH COLUMBIA AND ITS MAPS.

BY REV. A. G. MORICE, O.M.I., M.A.

I.

That part of British Columbia which is commonly known as the Northern Interior has fared rather badly at the hands of geographers. It coincides with the greater portion of that former paradise of the fur traders, which they used to call New Caledonia, and whose emporium was Fort Saint-James, on Stuart Lake—a region of deep lakes and swift rivers, of picturesque mountains and endless forests. Over eighty years after the establishment of the first commercial posts in that country, its geographical features remained represented on official maps by the merest guesses and, as far as its lakes were concerned, by the wildest exaggerations, except in the case of the beaten tracks of the fur trade. Nay, even these were very far from correctly reproduced. Most of that stretch of land was usually labelled: lake region, an implicit admission of ignorance on the part of the cartographers.

Geographical elements remained in that unsatisfactory state until 1890, when two land surveyors, Messrs. Poudrier and Gauvreau, arrived in the country, in order to survey and map it out, in prevision of an intended booming of the Bulkley and Nechako valleys in the interest of agriculture. The results of their labours were consigned on a map, published in 1891, which embraced within its scope most of that "lake region". This was so far the only one that confined itself to the Stuart Lake and adjoining districts. Unfortunately it proved to be the most unreliable of all. It even originated gross errors, one of which, designed to honour the present writer, has never been rectified in spite of his protests against it.

Things had therefore gone from bad to worse when copies of a newer and better drawn map, issued in 1895, were sent me for appreciation and corrections by a member of the Turner ministry, Victoria. By

Digitized by Google

that time, however, such a mass of inaccuracies had accumulated thereon, owing to its copying preceding works purporting to show the geographical, hydrographical and orographical features of the Northern Interior of British Columbia, that I had to decline the task proposed to me, feeling, as I told my correspondent, that an entirely new map of the country had become a necessity.

These will, no doubt, appear rather sweeping assertions to the reader who has not explored that region as I did for the space of twenty-two years, during which I went up and down foaming streams previously unknown to geography, navigated out of the way bodies of water and climbed steep mountains, which I feel confident will not before long receive the visit of any white man, though people of my own race have multiplied in the adjoining country since the time I had to leave it. Those who do not know how were spent the weeks which were supposed to be devoted to exploration by one of the two well-paid Government officials responsible for the 1891 map will also be tempted to see a tinge of presumption in the present remarks and those which are to follow. These are written by one who, in the course of his own journeyings in the interest of science, had at his service scarcely anything but a passion for geographical accuracy, the good-will of his native companions and a mastery of their language, coupled with a boundless enthusiasm and a perfect contempt for danger and fatigue, all of which was aided by no mechanical means save a good watch, a telemeter, a mountain barometer, a sounding line, and a compass. In self-justification, therefore, I must be allowed to point out at the outset one of Poudrier's unaccountable misrepresentations, against which I certainly had a right to protest, and which can easily be ascertained by any one willing to repair to the quite accessible spot, or send thither a representative to inspect matters as they really stand.

In the course of my travels I located the sources not only of the Nechako but also of the Bulkley, a mad-like stream which had previously passed for unnavigable, especially in its upper part. Some knowledge of the untold difficulties I then encountered and of the hair-breadth escapes I went through, no less than of the expense to which I was put, in order to accomplish this and map out the course of both rivers from headwater to mouth would, I fancy, go a long way towards excusing the personal note and strictures which are bound to crop up through the following pages.

To return to the question of Poudrier's geographical errors. By about 54° 20′ N. latitude, the Bulkley receives from the east an insignificant

Digitized by Google

tributary which is twice crossed by the line of the Dawson telegraph, and which Poudrier gave out as being none other than the Bulkley, applying at the same time my own name to the upper part of the main stream itself!

There cannot be the shadow of a doubt that that gentleman never was at the confluence of the two rivers, any more than at most of the points to which he introduced us on his map, for, as I wrote some years ago, "a blind man standing there could not have fallen into such a gross error: the sound of the angry billows in the main stream would have cut short to any hesitation as to whence it flew".[1]

The Bulkley is an apparently very deep torrent which, in that part of its course, flows about due north in a straight line and is at least 125 yards wide, while the rivulet it receives and is represented as the main stream by Poudrier is, by actual measurement, not more than thirty-five at its mouth, which forms two wide angles with the Bulkley. Its sluggish and dark waters scarcely make an impression on the turgid and soapy waves of the latter. And yet it is this insignificant stream which was, and has to this day continued to be, represented as the Bulkley on all the official maps, while the same documents give out the latter as the Morice! As well would it be to call Blackwater the upper part of the Fraser above the confluence of the former, or take the Saint-Charles of Quebec for the headwaters of the mighty Saint-Lawrence!

That unfortunate mistake is still aggravated, in the case of the two British Columbia rivers, by the fact that the country drained by the smaller one being rather more fertile than most stretches of land in that latitude, it is proportionately important, and, as I have already said, that stream has long been crossed by the telegraph line, as it is, I suppose, to-day by the G.T.P. railway, at two points which, consequent on that misapprehension, are called North Bulkley and South Bulkley respectively.

Long before I could ascertain it *de visu*, I learned of this regrettable inaccuracy through the Indians, the best geographers in the world, and protested to the British Columbia crown minister who had sent me the last map then available against my name being used to designate a river that was already called the Bulkley. I suggested at the same time that if they were bent on attaching it to any geographical element in the Northern Interior, the unimportant eastern tributary of the Bulkley might be chosen therefor. That gentleman courteously answered me

[1] *Exploration de la Rivière Bulkley* (*Bulletin de la Société neufchateloise de Géographie;* vol. XXI, p. 101. Neuchâtel, Switzerland).

Digitized by Google

that due note was being taken of my remarks, and that the error complained of would be rectified in a future edition of their map.

Eleven years later, the McBride Government published at their expense a slightly reduced copy of the eight mile to the inch map which embodied the results of my twenty-two years of exploration, and, of course, thereby set right this and many other inaccuracies. To give an idea of the trouble I had gone to and the difficulties I had faced in preparing it, I may perhaps be permitted to state that, in addition to the altitudes of many points after my own observations, as well as the rapids in the rivers and the glaciers in the mountains, this showed the depths, sometimes in different places, of all the principal lakes, which I had obtained by repeated soundings effected sometimes during the most boisterous weather, gave the width of some streams I had measured, and delineated many new lakes, some of them quite important, which I had discovered in the company of Indians who had themselves never seen them before.

In proof of this the reader will herewith find, roughly drawn on a still further reduced scale, a corner of that map, together with an inset representing the same part of the country as it was previously shown on the latest of the Government maps.

Of what avail to science have been my humble efforts on behalf of geographical accuracy? We have already seen that the error concerning the so-called Morice R. has been perpetuated to this day—at least on the only map of British Columbia published after mine which has come to my knowledge, I mean that of 1913 which embraces the entire province within its scope. On the other hand, they have fairly well reproduced the outlines, or contours, of the lakes I discovered, a circumstance which renders still more abnormal the fact that they show as a tributary, under the name of Morice, a stream which not only carries the water of at least three large lakes, but is even on the new map more than twice the length of the pretended Bulkley of that work. Furthermore, my discoveries, rectifications and place nomenclature have been treated with a liberty and off-handedness for which I cannot easily account. Evidence of this will form the second part of my little paper.

II.

And first as to the linear part of that comparatively late piece of cartography. It must be admitted that a serious attempt at profiting by the data of my own map is noticeable throughout. The scale of the newer document being much smaller—thirty miles to the inch instead

Digitized by Google

of eleven on my printed work[1]—minor details cannot, of course, be reproduced thereon. But all the new lakes and rivers are unmistakably there, in their proper places and with their main outlines, apart from the smaller ones. I do not speak of the mountains and glaciers, since the official map contains no orographical elements. But why, I may ask, does it give in dotting or broken strokes the shores of Lakes Loring, Emerald and McBride? Is it to imply that I had them from hearsay? If so, I make bold to assert that, even in such a case, they would be more reliable than those given as undoubted elements by Poudrier's map. The Indians were so devoted to me and knew so well my scrupulousness in this respect that they would have drawn for me more accurate figures of lakes than they did for Mr. Poudrier, who obtained most of his data from that source, but was handicapped by a total lack of familiarity with the native languages.

But I explored in their entirety both Loring and Emerald Lakes, as testify the results of my soundings to be seen thereon in this connection, and from Mount Loring I had a fairly good view of L. McBride. At all events, I did not sketch with more care the neighbouring Dawson and Sinclair Lakes, which the Government map regards as trustworthily delineated. Therefore the outlines of those bodies of water should be as free from dots as those of the others.

We now come to the all-important question of place naming. I hold, and always acted on the principle, that two special processes must be avoided as much as possible in this connection. These are the bestowing on new geographical points of qualificative or animal names (such as Long L., Green L., Beaver R., etc.), and especially of Indian vocables. The former should be used at best very sparingly and when there is no danger of giving rise to amphibology, but one should abstain absolutely from the latter. Qualificative and animal names are but partially differentiating terms, since, on a late official map of British Columbia, I counted no fewer than seven Salmon Rivers, and, within one degree of latitude, the same document furnishes us with three Bear Lakes, two of which are tributaries to the same stream! What a confusion for the mind of the traveller and others must result from such an homonymy, and how is it that nobody would seem to have been tempted to propose a remedy therefor?

---

[1]Which I cannot help thinking vastly inferior to my MS., still extant, whose details are so minute that, with its aid, any traveller could, I fancy, recognize daily the particular point he might have reached along lakes or rivers.

Digitized by Google

But methinks I hear someone whispering that the proper way to avoid such an inconvenience would be merely to adopt the names in use among the Indians themselves. To which I unhesitatingly answer, and wish it to be understood once for all, that such a remedy would be much worse than the evil itself. When we have to deal with a country which is the habitat of an aboriginal race blessed with such a terribly difficult and extremely delicate language as is the Déné family, then by all means keep clear of its nomenclature, unless you want to become the laughing-stock of both Indians and scholars, and cause also among the common people untold difficulties and endless diversities of pronunciation.

It is utterly impossible to render correctly many native names without diacritical marks or special letters, which would be out of place on a map and perfectly unintelligible to most observers. Now not only has the British Columbia Government map issued after the publication of my own most grievously sinned in this respect, but it would seem as if its compiler had purposely attempted still to add to his misdemeanour by expressing altogether different sounds by one and the same letter. Take, for instance, the words Chuchi, applied to the lowest of the Nation Lakes; Pinchi, a village on Stuart Lake, and Bednesti, the pretended native appellation of a small sheet of water just west of Fort George. The desinential *i* of the first is pronounced as the *ee* of *see*, that of the second as the *ay* of *say*, and that of the third as the *igh* of *sigh*. Where is the reader, student or traveller, who will guess that? Moreover the last name is but a ridiculous corruption of the native *pît œnîstai*,[1] "the large lake trout",[2] *pît*, "has eaten its fill", *œnîstai*—a circumstance which, on the other hand, clearly shows that the applying of English translations of aboriginal designations to geographical points is out of the question.

Yet there is on most maps of the Northern Interior of British Columbia a supposed instance of such a translation. It is a curious case of onomastic evolution, due to popular ignorance and misconception. As such, it deserves more than a passing mention. I here refer to the name of that long lake which sits astride the line of the 54th degree of latitude, just to the west of Fraser Lake. The 1913 Government map calls it Francois Lake, meaning, of course, François L. Is that a man's name? It would seem that some cartographers thought so, since they changed

[1]The circumflex accent on a vowel renders it long, and *œ* is the equivalent of *e* in French *je*, *te*, *le*, etc., a sound which is unknown in English. *Ai* corresponds to English long *i*, which must not be confounded with *ĭ*.

[2]*Salvelinus namaycush*, W.

Digitized by Google

it to Francis L., under the impression, no doubt, that they were translating it into English. Yet nothing is farther from the truth. On the latest official piece of cartography it is merely an antiquated form of the word *Français*, or French.

Now it happens that the natives originally knew that body of water under the name of *Nita-pœn*, or Lip Lake, out of consideration, probably, for its peculiar shape. But the dull-eared employees of the early fur-traders having learned, by their commerce with the Carrier Indians that *Neto* meant French, or Whites, and failing to grasp the difference between this word and *Nita*,[1] gradually came to call the lake "Lac Français", or French L., among themselves. Following suit, the younger generation of aborigines insensibly adopted that denomination, and translated this would-be translation into their own dialect, saying, as they do to this day: *Neto-pœn*, French Lake.

François L. is a nonsense, or at least an unwarranted anachronism, on a modern publication.

Another large body of water which is misnamed on the last Government work lies some distance to the north-east of Babine Lake. That document gives it out as Tacla Lake, no doubt from a conviction on the part of its compiler that such is the name the Indians apply thereto. Now there is no such word as Tacla in the Carrier language—that of the aborigines who ply on its waters. *Tha-t'la*, the second syllable of which is strongly "exploded", is evidently the term which is meant. Its first part refers to water, and the second to the farthest end of a lake, that which is opposite to its outlet. This is what used to be translated Fond-du-lac, or bottom of the lake, by the French Canadians in the service of the early traders.

If the reader will now kindly glance at any of the old maps of the country, he will realize that, just at the farthest extremity (*tha-t'la*) of the body of water in question, there used to stand a post called Bulkley House, which continues to be marked on the new Government map, though abandoned for at least fifty years—another anachronism. Said post being situated at Tha-t'la, the whites no doubt imagined that this was the native name of the whole lake, instead of applying only to the spot where their "house" was situated.

The Indians know that lake under the name of *Rhél-rœ-pœn*,[2] or Burden Lake. But I am free to confess that, in the case of such a well-

[1] Pronounced *Neetah*.

[2] The *l* of *Rhel* is a particular sibilant consonant quite different in value from common *l*, and, of course, without any equivalent in English.

Digitized by Google

known geographical element, no change of name would be advisable. Hence we may continue to call it That'la, or less properly Thatla. At all events, Tacla is out of place.

III.

Coming to minor details, I may be pardoned for failing to understand the treatment most of the names I had given to the lakes I had discovered and to a few that were previously known under would-be Indian vocables have met at the hands of the new British Columbia Government cartographer. It is, I believe, universally conceded that he who discovers a geographical point enjoys the right of naming it. When, added to this, the same party carefully sketches and maps it out, his right to such a privilege is doubly sure. I thought therefore I was guilty of no undue presumption when I acted on that understanding. I am now sorry implicitly to be told that I had exceeded my rights, and that all my expenses, fatigues and hardships, the consequences of which are to affect my health for the rest of my life, have been in vain, or about so, as far as the geographical nomenclature of that country is concerned. For only nine of the names I gave have been retained, viz., those of Lakes Loring, McAulay, McBride, Emerald, Lucas, Morrison, Fulton, Sinclair and Murray—the two last rather small sheets of water.

Why have not the others been adopted? They represented previously unknown or unnamed lakes. Could this be owing to the fact that a few of them were French? If that be the reason, why reject such good old English appellations as Cambie, Vowell, Boyle, Kennedy, Newcombe, Gladstone, Newman, Peters, McKinley, McKay, Turner, Hamilton, Bell, Loon, Finger, Raft and others?[1] The rejection complained of cannot therefore have been on the ground of the language to which a few of these names belonged, especially when we consider that the same official map contains itself such undoubtedly French expressions as Lac la Hache, Lakes Tremblay, Babine, Le Blanc, Tranquille, Lac des Roches, Quesnel, Tête Jaune Cache, Bonaparte and Doré Rivers, Pierre Creek, Grande Prairie, and even, as we have seen, L. François, instead of the English denomination, French L., which I have on my own map.

[1]Will the reader believe that even Kitchener and Roberts were deemed unfit names for geographical elements in a British colony? No room for the lakes to which you applied them, will perhaps object the new cartographer. To whom I will observe: Is not this because you exaggerated the size of another?

Digitized by Google

Why then discard not only the French but the unequivocally English names I had given? These would either recall an historical fact as in the case of Cambie Lake, perpetuate the memory of great men as Gladstone, Newman and McKinley, remind of a deserving British Columbia statesman as Turner or of an honoured Dominion official as Vowell, as well as predicate some particularity not shared by any other geographical element, at least in the vicinity of the points thereby denominated, as Finger, Raft and Loon.

Instead of that, the new cartographer, or his inspirer, who never saw any of these points, let alone toiled to discover them, unceremoniously replaces their names by what he must have naively taken for the term by which the former are called among the natives, and succeeds in each and every instance in falling into a more or less ludicrous mistranscription or blunder. It would be too long to enter into full details in proof of this assertion. Just two or three cases must suffice.

South of Emerald L. lies an important body of water which is labelled Tahtsa on the 1913 map. There is in that region no geographical point so named by the Indians. That lake had no existence on any map previous to the publication of mine. It cannot therefore be denied that I did discover it. Indeed I navigated it lengthwise and across on three different occasions, and once its deep[1] and angry waters almost swallowed me and my companions in the midst of a storm. I fail to see why the Government man should have scorned away the name Dawson I gave it and by which the natives call it to-day in their intercourse with the whites, for the sake of a meaningless nonentity, while the same man retained the appellations which I applied to the neighbouring pieces of water (Lakes Sinclair, Emerald, McAulay, Loring and McBride).

Another instance of unintelligent misnaming is that of the would-be Ootsa, which on my map is Cambie L. In the fall of 1876, the late Mr. Cambie, a civil engineer in search of a route for the then projected Canadian Pacific railway, traversed French L. in its whole length, and discovered the important basin to which I have given his name and of whose shores I delineated the details now reproduced by the 1913 map. I will ask any sensible reader: Under the circumstances, which is the better name, Cambie or Ootsa, a supposed word which exists in no language that I know of? For the natives who hunt around it call it not Ootsa, but Yûtsû (or Yootsoo, both *oo's* being very long).

Nor is this all. Quite close to Dawson L. is to be found a most important body of water, which is the southern source of the Nechako.

[1]A sounding line 646 feet long failed to find any bottom.

Digitized by Google

This is without doubt the finest, as well as the deepest[1], of all the British Columbia lakes, combining as it does the advantages of vast stretches of the clearest water and beautiful islands, one of which is about nine miles long, with an exceedingly picturesque coast: high snow-clad mountains with greenish glaciers that shine in the sun and boisterous cascade-forming brooks on the one side, and dense forests of a deep green on the other.

Now will the British Columbia Government cartographer, or those who are responsible for the name substituted on his map, kindly tell me where he took the delineation of that lake such as it stands on that document? Who is he who discovered it, minutely sketched its coast, islands and surroundings, and first presented the whole to the geographical world? I originally gave it the name of the oldest among my crew—I cannot say my guides, since, though they were Indians, they had never seen it before—and called it Saint-Thomas L. But when we gradually became aware of its importance, the fellow generously refused to have it named after himself and called it Morice, a name to which he and the other Indians have ever since stuck in their relations with the whites.

Perhaps I was mistaken in this, but when drawing up my map I thought that it was best for me to conform to the usage that was then prevailing, and labelled it thereon L. Morice. The Government cartographer, however, promptly called me to order, though he could not deny that I was the party who discovered it, and thought he would improve on me by dubbing it Eutseuk. What does that mean? Who calls it so? Certainly not the Indians, since they know it under a totally different name. We have seen that they call Cambie L. Yûtsû. To them Morice L. is *Œte'auh Yûtsû*, or "The Farthest Yûtsû".[2] Is this unwieldy appellation preferable to the name of its discoverer, which is easily pronounced even by English-speaking people, since it is more English than French?

Though I am not personally responsible for the vocable which that sheet of water bears in the country and on my map, I do not waive my right to christen it, and if I am not considered worthy to stand sponsor therefor as far as its name is concerned, I ask that it be called either Laurier or Leo, the latter alternative in honour of the Pontiff in the

[1] I found it to be no less than 780 feet deep in one place (V. map).

[2] *Œte-* corresponds in Carrier to superlative—denoting *-est* of farth*est*; *'auh* (the ' standing for the hiatus or vocal stop) means away, and *Yû-tsû* hints at the fact that it is a body of water very (*yû*) low down (*tsû*).

Digitized by Google

reign of whom it was discovered. Eutseuk is simply ridiculous and perfectly meaningless to anybody but the Government cartographer. Furthermore, will this gentleman kindly tell us how this word, which seems to have been invented by some mystifier, is to be pronounced?

IV.

Yet impartiality bids me note one solitary improvement on my own nomenclature to the credit of the 1913 map. I had called Summit L. a medium-sized piece of water which is the source of the real Morice R., twice crossed by the telegraph line. This name has now been changed to Maxim, and thereby is removed the danger of confounding it with other analogous geographical points already so denominated on British Columbia maps.

As will appear from the foregoing, the principal failing of the new map—new to me,[1] though already five years old—lies in its arbitrary, meaningless and I am almost tempted to say unhistorical and unpatriotic nomenclature. I have purposely chosen the quiet pages of a strictly scientific publication instead of the less discreet columns of a newspaper to expose its shortcomings, and I do sincerely hope that due attention will be paid to my remarks when it is proposed to have a new edition of that map. Thus will at last be fulfilled the promises that were made to me in 1896.

Should any of my strictures on the tracing of the river courses and continuity of the same, as, for instance, in the course of the so-called upper Bulkley, be deemed open to discussion, I would say to those in power: By all means, do send even the least experienced party to ascertain on the spot the appositeness of my statements, and I shall be glad to abide by his decision. Even a stone-blind man will do.

I now beg to close by adverting on a few more points of kindred nature, wherein I cannot help finding the official cartographer at fault. The most important among these refers to the status of the Parsnip R. with regard to the Peace. If we are to believe the new map, which in this respect faithfully copies one of Poudrier's mistakes, the former is the upper part of the latter. Unfortunately this is wide of the mark. The Finlay, which on said work seems to be but a narrow tributary of the Parsnip-Peace River, is in reality the first division of that mighty

[1]Until last year, when it first came to my notice. The unpleasantness which attends such recriminations as the present caused me to postpone putting them on paper until friends urged me not to delay any longer.

Digitized by Google

fluvial artery which, though naturally one, is known under different names according to the region which it drains, being called the Finlay down to the confluence of the Parsnip, then the Peace until it passes by L. Athabaska, after which it becomes the Slave as far as its fall into Great Slave Lake, and finally the Mackenzie down to the sea.

The Finlay carries at least double the volume of water found in the Parsnip—perhaps three times as much. The latter, which flows through a comparatively level country, though parallel with mountains in the distance, is rather broad at the time of the spring freshets, and scatters its waves in a multitude of channels, forming a corresponding number of islets. But in its normal state it is shallow, and, quite a distance from its source, even canoe navigation is rendered difficult in the fall by the lack of water in not a few bars.[1]

The case is very different when we come to the Finlay. This is so important a stream that, in the same season, even as far up as the vicinity of Fort Grahame, it looms up in the distance with almost the proportions of a lake to the wayfarer who reaches its valley after a long tramp from Bear Lake through mounts and vales, such as was effected by the writer in the course of his explorations. No wonder, then, if the Sékanais, through whose territory it flows, call it *Tcâtcî*, that is the Big Water. The Parsnip cannot be compared with it as regards bulk and importance. Nay, it seems to me that it needs only the use of a little common sense to realize this, even after a perfunctory inspection of the Government map as it stands.

Consider the length of that river, and then turn to the Parsnip; ascend the former in spirit to its headwaters, *Thâtage*,[2] or Narrow Water. Then count the important streams it receives as it flows down: the would-be Ingenika, my Hamilton R.;[3] the Mountain Goat R., the pretended Spika of the official map; the Omineka, or Freshet R., together with such a long stream as the miscalled Mesilinka, I mean the Raft R., which I partially descended by means of the primitive mode of locomotion responsible for its English name, and finally the Manson. Is it reasonable to expect that a river which, through itself and tributaries, drains such an extent of country should not be larger than another which,

[1]The Parsnip can be forded in several places not very far away from its mouth, an assertion which it would be preposterous to make in connection with the Finlay.

[2]Cartographers have, in this case, duly recorded the native *th-* expressive of water; but this should be changed to *tc-* (English *ch*) here, because that lake was originally named by the Sékanais in whose country it is to be found.

[3]So named after the late Thos. Hamilton, a whilom commander of Fort Grahame.

Digitized by Google

apart from the Nation, receives scarcely anything but mountain brooks and is itself considerably shorter? To ask the question is to answer it.

The reason why Poudrier's map attributed such generous proportions to the Parsnip is probably to be found in the desire of its compiler to record the numerous islands it forms as it spreads through the land. This is difficult of accomplishment without considerably exaggerating its importance, and I must admit that even my own printed map overdoes the width of that stream.[1] But that work allows the Finlay proportions which must have left no room for hesitation as to the respective relations of that river and of the Parsnip to the Peace-Slave-Mackenzie. By reversing the proper order of things, even such as common sense suggests after a comparison of lengths and tributaries, the new cartographer has perhaps tried to correct nature. This is a difficult task and it cannot be said that he has succeeded in it.

Before we leave that northern region, I may also be allowed to remark that, for once, the same party seems to have overlooked my own tracings of river courses and lake outlines, unaware, probably, of the fact that I personally explored that part of the Northern Interior as well as most of what is found on my map. My Duncan L. is much enlarged on his and lacks altogether its real contours, while Hamilton L. is conspicuous for its absence.

South of this he further gives us, on the apex of the northern fork of Babine Lake, a Hudson's Bay Company post which has long been transported to the outlet of that body of water, as may be ascertained by a reference to my "History of the Northern Interior of British Columbia". On the other hand, he would have us believe that Fort Babine, which, as everyone knows, stands at the upper end of the lake of the same name, is now "abandoned". If so, where is it to be found? We have only to take the reverse of what is marked on the new map to get a correct answer. It is where it says it is not, and it is not where it tells us it is.

Having thus wrongly located Fort Babine, by placing it 28 miles from where it stands, our man sees fit to honour it with the company of satellites, and draws along the shore four large islands forming in front of it a crescent-like figure. Nature has not been so accommodating: there is not a single island, large or small, in that part of the lake, which is on the contrary conspicuous for its unbroken expanse of water.

As if he had exhausted himself in fabricating those islands, the same artist cannot see the many similar elements which dot Stuart L. and in

[1] I was never given an opportunity to correct the proofs of that map.

Digitized by Google

one part of it constitute a veritable archipelago. Though some of them are quite important, his map does not show one of them, while, imperfect as is the printed copy of my own, it contains at least thirty.

An inaccuracy of a different kind will be found on the new official map just south of French L. While its author has unduly diminished the dimensions of Peters' L., which he calls Uncha, he has proportionately exaggerated those of an adjoining piece of water, to which I gave the name of Raft L., as well as of a third, my Knapp L.,[1] which he leaves unnamed. But these are minor details. The chief error of the Government man in this connection consists in that he has made that lake a tributary to Saint-Mary's L. (his Cheslatta—he means Tsist'-latho), while as a matter of fact its waters flow into French L. through an outlet in the north (not in the south as he has it), as well as Peters' L. itself.[2] The height of land between the two basins lies just between Raft and Knapp Lakes. I have navigated these three bodies of water and explored their surroundings; so I know whereof I am writing.

Lastly, the compiler of the new Government map appears somewhat uncertain or ill-informed as to the real course or identity of the Blackwater R. (Mackenzie's West Road R.), south of Fort George. He duly calls it by that name in its lower part, but labels it Nazko R. further up, thereby creating the impression that, at a given point, the Blackwater receives the Nazko from the south. But this last name, which should be Nazkhoh, is the Indian for the whole stream which we know as the Blackwater.[3] If therefore we are bent on having the native name of that

[1]Called after the secretary of the Geographical Society of Neufchâtel, Switzerland.

[2]We find some American ethnologists who would fain deride what they are pleased to call the credulousness of those who believe in the relatively large numbers of the Indians previous to the advent of the whites among them. Now I found, on the north side of Peters' L., the site of an abandoned native village to which led an old trail, deeply beaten in hard ground and denoting very frequent use, but now overgrown with the trailing plant vulgarly called kinnikinik (*A. uva ursi*). It may be worth the while to note that, apart from a small village still existing on Saint-Mary's L. and another on the upper end of Fraser L., there is not at the present time the least centre of population within the territory covered by the accompanying extract from my map—a stretch of over three degrees of longitude in width. All the places marked by the *o* sign thereon are simply the sites of old villages of which there has been not a vestige left, and only a few of them are recorded.

[3]The etymology of *Nazkkhoh* is rather uncertain. *Khoh* (with a very guttural *k* sound) stands, of course, for river; but *na* may be either the Carrier preposition corresponding to our word "across", or the desinential part of *Œtna*, foreigners, that is, here, Shushwaps. In the first case, that name might be translated "Cross River", or the stream that one has to cross in order to go north or south; or "Shushwap River", namely, perhaps, that which one has to cross to reach from the north the land of those Indians.

Digitized by Google

Digitized by Google

Digitized by Google

river, either all mention of a Blackwater should be avoided, or the former should be added within parenthesis to the latter, in order to show the identity of the one with the other.

On my map I met that difficulty by calling Lesser Blackwater the western branch of that stream, whose valley Mackenzie followed, and which heads near Lh'kazkhoh, transformed into unrecognizable Ulgako by the British Columbia reformer of native idioms.

I might also inveigh on the impropriety of calling Chilako a stream which is known as *Tsa-la-khoh*, Beaver-hand-river, to the Indians—the Mud River of the whites. But this would unwittingly lead me to return to the question of the ineffable misnomers consequent on the adoption of the wrong principle of seeking, instead of avoiding, aboriginal names, which are in most cases impossible of transcription with the mere letters of our alphabet. I have already dwelt long enough on that point to show the unwisdom of those who were responsible for the 1913 map of British Columbia.

Digitized by Google

Digitized by Google

EDUCATIONAL REFORM;

ITS RELATION TO A SOLUTION OF THE INDUSTRIAL DEADLOCK.

*By C. V. CORLESS, M.Sc. (McGILL).

MR. PRESIDENT, LADIES AND GENTLEMEN:

Half a century ago, the greatest of the world's democracies learned by one of the bitterest lessons in history the absolute impossibility of harbouring the institution of slavery, autocratic rule over a portion of our fellow men, in a democratically free country. To-day we witness the selfsame struggle on a vastly more gigantic scale, in a world effort to uproot autocracy as a principle of rule from its last political stronghold on our planet. Thus have the two principles of liberty and domination ever struggled for ascendancy since a member of the human species first consciously gained control of others for his own ends. Thus will they ever struggle until all recognize that the only justice in social control rests on securing the greatest benefit to all—not to some; and until it is universally recognized that such control cannot justly be super-imposed but must arise from society itself, by its own consent and with its own approval. A taste of democratic freedom is intoxicating. Once acquired, it knows no bounds. But such freedom, if it is to be real, must be based on social intelligence and a well-developed ethical feeling, or it may take the form of license, that is, failure to recognize the equal rights of others. When this condition is reached, democracy becomes self-defeating.

Notwithstanding so clear a recognition of the incompatibility of democratic freedom and autocratic rule in political affairs, so clear that it has become a world issue, men have, for various reasons, been very slow to recognize this as the root cause of the existing antagonism in industry. Nearly all institutions in free countries have become democratic, that is, controlled by the consent of the constituents. In industry, the autocratic method still largely prevails. There is no possibility of this condition remaining permanent. The continual strife between capital and labour in the industrial field is rooted in this. It will not,

*Director and Manager of the Mond Nickel Co.

Digitized by Google

it cannot, be eliminated until we have gradually developed a spirit and evolved a method which will effectively democratize industrial relations. On the one side, we have capitalists lined up and lining up in combinations to look after what they believe to be their own interests. On the other, we have labour combining more and more in trade unions. Each of these works secretly for what it conceives to be its own ends. Neither realizes clearly that the aims of both are, or should be, one and the same. Capital has dominated and in most cases autocratically controlled the situation. No concerted action has been taken by both sides to get together and study the business of production as a co-operation of capital, intelligence and labour, which it really is. We are all vitally interested in this situation, for the existence and welfare of all society depend on the efficiency of the co-operation of these factors of industry. Society cannot forever continue to allow the capitalist to jeopardize the welfare of us all by insisting on an antiquated, autocratic attitude towards labour in production. A way out must be found.

Clearly such solution of the difficulty must consist of two factors. The present antagonism, which is very real and which is based, I believe, on a deep economic misunderstanding and narrow view of the place and function of industry in society—a failure to see clearly that the true end and purpose of industry is to contribute in the most effective manner to human welfare, in place of considering human welfare as subsidiary to industry—and which further arises from lack of good-will and the higher standard of ethical feeling which this view implies, must gradually be eliminated by the practical but thorough inculcation of this saner economic understanding and ethical standard. In addition to such thorough social and economic training, for which our educational institutions must be held mainly, if not entirely, responsible, efficient machinery must be created for getting together and smoothly adjusting the inevitable differences of opinion which will always arise between employers and employed. If this social training is coupled with and arises out of such reformed educational programmes and methods as will make it a natural outgrowth of real experience—a much more scientific, practical and thoroughly democratizing education than that imparted under the present educational régime—and if it is extended down through all our educational institutions so as to reach all future employers and workmen, the existing atmosphere of suspicion and antagonism will gradually give place to increasing confidence and understanding. There will then be no insuperable difficulty in creating and smoothly working an organization for giving expression to the essential

Digitized by Google

unity of aim and purpose of all the factors in industry, which will thus come to be realized by the rising generation. But if such a social foundation is not laid by our general educational programmes and methods, so as to form in all, or in the great majority, a basis for this saner economic and ethical understanding, this truly democratic spirit which must characterize both sides, such organization will be certainly a partial, and probably a complete, failure. Organization may express but will not originate the disposition to get together.

Just here lies the greatest necessity for reform in our whole present educational system. Our system has aimed too exclusively at developing individuals as such. If I may speak unreservedly, I would say that it is failing almost utterly in training each youth to understand his economic and social place and responsibilities in our present, highly organized, industrial, democratic society. This is no reproach. The present situation is a natural result of educational history and tradition, a matter I need not dwell upon with this audience. But, we have reached the parting of the ways. Those who are in closest touch with industrial operations will, I believe, agree with me that the social phenomena which come constantly under our observation indicate that a great readjustment in industrial relationships, based on a complete change of view as to the proper economic and ethical principles which should underlie the relations between capital and labour, must gradually be brought about, if industry is not to drift more and more towards deadlock, the signpost that marks the down-hill slope to revolution. The necessity of this clear view of whither we are drifting and of the broad principles that must guide us in this readjustment is most urgent. Without the forward vision, which can be given only by a clear discernment of economic and ethical principles, there can be no steady social progress—there will result only patchwork and makeshifts.

Hence we must look to our educational system as a whole, to form in each student brought under its influence: that knowledge and breadth of mind in economic matters; that saneness of view regarding industrial and all other social relationships; that sense of justice, that humaneness of feeling, that desire for the practical application of the 'golden rule' in all our communal affairs, that general ethical sensitiveness; which must form the indispensable, psychological condition and groundwork on which any final settlement of the industrial dispute must be based. For it is not the symptoms, but the cause, of this chronic ailment of the social body which we wish to root out. And all relationships in human society, whether good or bad, desirable or undesirable, are but outward

Digitized by Google

expressions of those psychological realities, those mental states—those understandings, ethical dispositions, mental attitudes—which it should be the fundamental purpose of education, in the broadest sense, to create and of which it is the business of our educational institutions, viewed in the narrower sense, to lay the foundation.

To a section of the Educational Association a few days ago I expressed my views on this subject in these words: "It is not the main business of our schools and colleges to impart that knowledge which is mere information; nor even to cultivate, to stimulate the power of, research, discovery and independent thinking—of vastly greater importance though this may be; but it is their main business, as I conceive it, to lay the foundation of, and as far as opportunity offers to build in each student who passes through them, that sound and sterling character which is manifested in all social relationships by standing four square to every temptation, economic or other. . . . Now sound character alone, the ethical habit, the determination to do right come what may, may suffice in the simpler relationships of life. But the great scientific and industrial progress that has been made within the past century has resulted in so enormously increasing the complexity and extension of human relationships, that the ordinary man, unless specially trained with that definite end in view, finds the greatest difficulty in framing for himself any reliable ethical judgment, in many of the difficult situations constantly confronting him. He is frequently unable to decide intelligently as to the ethically right course of action because he is unable to reason clearly as to the probable proximate and more remote social consequences of his choice. Of what use will mere ethical habits, sound character and good-will be, unless these are accompanied by, and based on, definite training leading to clear insight into the highly complex and intricate, political, economic and other social relationships into which practically every activity finally enters? Quite possibly two centuries ago, or even one century ago, before the invention of the locomotive, the power-driven machinery of great factories, the press, the telegraph, the telephone, the wireless, had led to those vast and complicated economic organisations and that high degree of specialization of work which characterize industry to-day, this special training may have been less necessary. But now, with the rapid progress of scientific discovery, invention and industry, increasing more and more these complexities of human inter-relations, the young adult just entering into independent life, unless specially trained as suggested, is caught in the economic swirl, without chart or compass. His bark may be sound and seaworthy but, if he has no knowledge of the

Digitized by Google

invisible cross-currents of the social sea on which he is setting sail, it is almost inevitable that he will drift far from his true course even though he may not be ship-wrecked. Will any one contend that an educational system that omits such special training in economic and other social relationships and responsibilities, such grounding in the essential principles of the social sciences—economics, civics, politics, ethics—not as abstract studies, but as principles deduced naturally from the student's activities, environment, experience—will any one contend that a system which does not incorporate the fundamental principles of these as a compulsory part of every course of study, can be counted as an adequate preparation for the complex relationships and responsibilities the maturing student is about to enter into?

"Man's comparatively recent scientific advance, arising mainly from the discovery that the true course of intellectual progress must be founded on a careful examination of the relations of the persons and things around him, has given him such an insight into the laws expressing these relations, that he has been enabled more and more to utilize nature's unlimited stores of matter and energy to his own advantage. But the great material rewards yielded by the practical applications of the physical, chemical and mechanical laws discovered has concentrated attention mainly on those sciences whose province is material nature. It seems not to have been generally so clearly discerned that a necessary result of the very great extension of co-operation and specialization required to reap these material rewards—to carry out great industrial enterprises, to build and operate vast systems of communication and distribution and to organize the complicated financial arrangements on which these are based—has been a gradual but almost incredible increase in the complexity of social organization. Our educational arrangements are being gradually adjusted to meet the industrial requirement. Engineering courses, industrial schools of many kinds, vocational classes and above all a generally greater emphasis on the scientific side of the programmes of studies followed by our more academic educational institutions, all indicate an awakening to this necessity, though very much still remains to be done even in this direction. This is perhaps of primary importance, since social advance must ever rest on, and to a considerable extent be conditioned by, intellectual and material progress. But in the direction of definite training of students to meet the second half of the problem, we may safely say scarcely a beginning has been made. So far as I am aware no systematic effort is made in our public schools and none in our secondary schools to meet this great need, while only very limited attention is given to this question even in our universities.

Digitized by Google

"Perhaps I may be permitted to express the opinion in passing, though discussion of this phase of the question must be excluded from this paper, that until the present almost pure symbolism in matter and methods of pedagogy in our schools, particularly in our lower schools, is replaced by a more scientific system—a system based on widening and deepening the real experience of the student by constant use of actual materials under such conditions as will deliberately and continually call into play the socializing influences of conscious organization and co-operation and of sharing and interchange of information by the young, in working together towards common ends—very little of real social value is likely to be accomplished. A mere course of book study or of lectures about these relationships will have little, if any, vital relation to the student's experience, will give him but little real insight into the social aims and purposes of the complex economic and civic activities in which he will share after leaving school and will have almost no practical effect on conduct. Among the gravest defects of our entire general educational system at present are the paucity of actual material things brought into use as an educational medium; the assumption that real education can be acquired chiefly through a carefully graded manipulation of the symbols of knowledge; the too ready acceptance of facility in the use of these symbols as a substitute for real education and the failure to discern clearly the undemocratic evils which necessarily result from a programme and methods based on this false conception. This has resulted in inefficiency in many directions. For we must conceive the intellectual aims of real education to be the acquirement of that power and eager desire which grapple quickly and intelligently with the difficulties of such original practical situations as arise in life outside the schoolroom; the attainment of that readiness and adaptability which quickly bring to bear on the solution of such difficulties, every available resource or experience, whether obtained personally, or through consultation with others, or from accumulated stores of recorded experience. It must develop: that originality which quickly discerns a new problem and seizes on its essential conditions; that concentration which leads to its clear statement and the rejection of irrelevant conditions; that judgment which selects with reasonable sureness the problem worth tackling and rejects the problem incapable of solution or the one likely to cause the frittering away of an unreasonable amount of time, energy or capital in effecting its solution. We must, in other words, regard it as the chief intellectual aim of school and college education to assist the student to acquire that vitalizing contact with, that intelligent

Digitized by Google

rooting of experience in, those real things and activities of the world in which he lives, which alone stimulate and sustain real mental growth, and an intelligent inductive study of which, secures best the material progress, and strengthens most the moral purposes, of mankind. This alone will form a secure foundation for civilization based on justice, goodwill and the acceptance of responsibility.

"It is this view of education that must prevail, it is the scientific means thus suggested that must be adopted, if an opportunity is to be afforded of giving the student a real insight into the fundamental principles that form the basis of social and moral science. Only thus can he acquire intelligent experience. And only by discovery of the moral and social aspects of his growing experience can any real foundation be laid for intelligent future decisions affecting conduct. The method of pure symbolism, if followed here, will prove as barren as did the routine of scholasticism of the medieval ages, before the methods of modern science furnished the clue, by following which the human intellect was guided out of the dismal darkness in which it had groped, with little real progress, for centuries." . . . .

The educational reform thus briefly outlined will, if effectively brought about, prepare the necessary economic and ethical basis—the indispensable, psychological foundation—which must be the primary condition of all real progress toward a solution of the existing industrial difficulty. Let us now turn to the other factor of the solution. Let us discuss briefly the factor of organization for adjusting differences between employers and employed, for expressing the more democratic spirit in industry, which it is one of the purposes of this reform in educational matter and methods to create. Let us examine broadly the principles which must govern the design and construction of the social machinery whose purpose is to bring together, on the basis of amicable discussion of differences, the two interests, now regarded as inherently antagonistic. The solution of a problem which appears very complicated is sometimes much simplified by a clear grasp of the underlying principle. Just as the application of the laws of gravitation greatly simplified the astronomical problems connected with planetary motions, so will a thorough application of the right principle here greatly simplify the many economic and other social problems which await solution in the proper adjustment of the relations between capital and labour.

I have already expressed the view that the great industrial strife is but one phase—it may be the final phase—of the struggle, many centuries old, for democratic freedom. In politics, democratic peoples

Digitized by Google

have attained to practical equality; in economics, they have not advanced beyond subordination. This 'half slave, half free' condition of society cannot be other than a transition stage in our onward march toward a fuller freedom. It is my belief that the progressive solution of this industrial difficulty will most readily be found by accepting this view as a guiding principle and gradually conforming our views, our habits of thought, our mental attitudes to this conception. This will form a standard whereby we may so adjust the many industrial differences which arise from time to time, as to ensure real progress toward social harmony and justice, rather than mere temporary evasion. I assume, of course, that it is such real progress, and not mere evasion, that is desired. I have no wish to minimize the difficulties which, because of the necessity of gradually educating each side to higher ideals, I realize to be very great. But great as they are, they will only become greater—they are, in fact, insuperable—if tackled without a guiding principle.

At the recent meeting of the Canadian Mining Institute in Montreal, I discussed the principles of such an organization under the title: "The Whitley Scheme; A Step toward Democratizing Industrial Relations"—in part, as follows:

"It will, of course, be at once clear to all who give earnest thought to the matter, that any real improvement in the industrial situation implies not so much a change of external formality in relationships between the parties to the industrial strife, as a change of heart. No mere change in tactics will answer. Real co-operation, unity of aim and purpose, feeling of partnership in industry, can arise only from a clear-headed understanding of the deep, underlying, economic realities of the situation and a sympathetic determination to act on the square. When this economic understanding and this ethical determination are reasonably developed on each side, there will be no insuperable difficulty arising from creating machinery, organization, means, for getting together. But, if these mental conditions do not pre-exist, the most perfect machinery that can be devised for the purpose will be of no avail. There will be no intelligence to guide it and no motive power to actuate it. Hence, those who have this problem at heart and have any real understanding of the essence of it, will make use of every available educational influence to this end. Clear understanding, essential cordiality, and downright good-will may succeed even with imperfect machinery. But without these, the whole arrangement becomes a sham, a makeshift, a temporary bulwark that only increases the disaster when it finally gives way.

Digitized by Google

"Nevertheless, proper organization for getting together is not to be despised. Suitable and efficient arrangements for this purpose will go far towards maintaining a proper and sympathetic atmosphere and will assist in keeping up and in increasing good-will. They will also furnish the best opportunity for continuing that democratic education whose groundwork we are pre-supposing as prepared during school life. Bungling organization, like badly designed machinery, causes much loss in friction and may lead to an early breakdown.

"In this creation of democratic organization for unifying the aims of capital and labour, Great Britain is once more the pioneer. We instinctively turn to her for industrial experience, as a child turns to a wise parent. Her experience in industry is many centuries older than ours. Her labour is much more highly unionized. Her trade unions have passed through two centuries of struggle. Her differences between labour and capital are more clearly defined. Her class distinctions, for other (historical) reasons, are more marked—a fact that has added to the bitterness between capital and labour. These conditions had brought the industrial dispute in Great Britain to such a stage that, by 1914, many felt that such general strikes were imminent, as would amount almost to, if they did not end in, a revolution. The war suddenly diverted attention from the quarrel. Though some domestic bickering has continued, all parties loyally joined hands in the superhuman effort against the common enemy. The war has, at least for the present, removed from capital all self-complacency, which was a large factor in the domestic strife. The nation is already face to face with an inconceivable debt which is mounting at an appalling rate. The food supply is threatened. The nation is about to put forth its extreme exertion. There is no room now for old quarrels. Dust and cobwebs have been cleared away. England is never at her best until her back is to the wall. It required three years of war to brush away the last cobweb of self-complacency. She is now not only thoroughly aroused to fighting mood, but has had her creative energy quickened by the crisis. In the awful throes and agony of the past year of war, Britain brought forth an industrial idea which, if broadly and wisely backed up in future by educational preparation, seems calculated to effect such a revolution in industrial relationships as will remove the malign social results of the pernicious economic policy followed since the industrial revolution of a century ago. In the blackest year of the war, just past, the British Government appointed a Commission whose principal work was to inquire into the causes of industrial unrest and to make suggestions for

Digitized by Google

removing the causes of discontent. The work was quickly and thoroughly done. The whole country was divided into eight industrial areas to each of which was detailed a small commission of three, consisting of one representative of employers, one of labour, and an impartial chairman. . . . While these industrial commissions were at work, a short preliminary report was sent to each by a sub-committee of the recently created Reconstruction Department, which at that time had merely the status of a committee appointed to consider the whole problem of industrial relations from the standpoint of post-war reconstruction.

"The chairman of this sub-committee was Mr. Whitley, whose name, for brevity, has been attached to the committee, to the report and to the general scheme embodied in the report. The broad recommendation of the Whitley Committee was the establishment in every organized trade of an Industrial Council, representing both employers and workpeople and having as its object 'the regular consideration of matters affecting the progress and well-being of the trade from the point of view of all engaged in it, so far as is consistent with the general interest of the community.' This recommendation, modestly called an 'Interim Report on Joint Standing Industrial Councils,' was, in June of last year, sent to each of the eight small Industrial Commissions, who quickly secured for it a consideration by more than one hundred Employers' Associations and Trade Unions all over the country. The greatest interest in the proposal was manifested both by the industrial bodies concerned and by the press. There appeared to be at once a general feeling of relief that a possible solution had been found for what had come to be regarded as practically a deadlock. Nothing could indicate better than this feeling of relief the essential soundness at heart of both employers and employed. By October the replies had been received and correlated. The answers of nearly all of the Trade Unions and of most of the Employers' Associations were 'overwhelmingly in favour of the adoption' of the general principle of the Whitley Report. Backed thus, the Minister of Labour on October 20th informed the Employers' Associations and the Trade Unions of the decision of the Government to adopt the Whitley Report. The document announcing this decision by the Government made it clear:

(1) that Joint Standing Industrial Councils be established in all the well-organized industries with as little delay as possible;

(2) that these Councils would be considered by the Government as 'official standing Consultative Committees on all future questions affecting the industries which they represent' and

Digitized by Google

would be the 'normal channel through which the opinion and experience of an industry will be sought on all questions with which the industry is concerned,' and

(3) that the Councils are to be 'independent bodies electing their own officers and free to determine their own functions and procedure with reference to the peculiar needs of each trade.' These autonomous councils will thus 'make possible a larger degree of self-government in industry than exists to-day.'

"These Joint Standing Industrial Councils, of national scope for each well-organized trade, will be supplemented by District Councils and these again by Shop Committees, on both of which masters and men will find equal representation.

"The scheme has met with the approval of the Council of the Federation of British Industries, the most representative organization of employers in Great Britain, and of the Trades Union Congress, and to all appearances is in a fair way to success.

"Mr. Wilson Harris is responsible for the statement that the idea of Joint Councils of masters and men originated with Mr. Malcolm Sparkes of London, an employer in the building and allied trades. He had 'laid before the men's unions in these trades a memorandum on industrial co-operation. The painters and decorators took the memorandum and applied it.' Their experience with the Industrial Councils already extends over about a year and has proven their practicability. The original purpose of these Joint Councils was, to use their official statement, 'to promote the continuous progressive improvement of the industry, to realize its organic unity as a great national service, and to advance the well-being and status of all connected with it.' This, as a spontaneous expression of idealism by a workmen's organization, is of deep significance. The District Councils in this trade have met regularly now for about a year under the masters' chairman and the men's chairman alternately and have successfully carried out some important constructive work at various centres in the country besides averting some disputes. The Whitley Committee is said to have received the original suggestion from this memorandum by Mr. Sparkes and elaborated it. It may later prove to be true, as in many other great movements, that when the time is ripe the same idea springs up in many minds at about the same time. Perhaps I may be allowed to remark in passing that the psychology of the social mind must never be lost sight of, if the study of the psychology of the individual mind is to be most fruitful. As well try to understand the anatomy and physiology of the hand without

Digitized by Google

reference to the alimentary, circulatory and nervous systems, as hope to succeed in a study of psychology of the individual mind without reference to the social mind with, and in, which it functions.

"On considering the question of representation a little more closely, it seems probable that the labour representatives on the District and National Councils under the Whitley Scheme will all be trade union leaders while the representatives of the employers will all be professional managers. The workman at the bench or lathe or loom or in the mine or elsewhere is generally not in close sympathy or close touch with either. If he is to feel a real co-operation between those who direct and those who perform the work, it will be through the Shop Committees. Success of the scheme will largely depend on perfectly frank, human intercourse between the representatives of both Councils and Committees, but above all, of the Shop Committees. If, as is hoped, 'such an atmosphere will be created that trade disputes will never be carried to the breaking point,' there will have to be, of necessity, the greatest sympathy, frankness and cordiality between the representatives of the workmen and of the management on these Shop Committees."

. . . . . .

The spirit underlying the "Whitley Report" and the remarkably changed attitude towards organized industry are well shown in the last four paragraphs which are here quoted:

"23. It may be desirable to state here our considered opinion that an essential condition of securing a permanent improvement in the relations between employers and employed is that there should be adequate organization on the part of both employers and workpeople. The proposals outlined for joint co-operation throughout the several industries depend for their ultimate success upon there being such organization on both sides; and such organization is necessary also to provide means whereby the arrangements and agreements made for the industry may be effectively carried out.

"24. We have thought it well to refrain from making suggestions or offering opinions with regard to such matters as profit-sharing, co-partnership, or particular systems of wages, etc. It would be impracticable for us to make any useful general recommendations on such matters, having regard to the varying conditions in different trades. We are convinced, moreover, that a permanent improvement in the relations between employers and employed must be founded upon something other than a cash basis. What is wanted

Digitized by Google

is that the workpeople should have a greater opportunity of participating in the discussion about and adjustment of those parts of industry by which they are most affected.

"25. The schemes recommended in this Report are intended not merely for the treatment of industrial problems when they have become acute, but also, and more especially, to prevent their becoming acute. We believe that regular meetings to discuss industrial questions, apart from and prior to any differences with regard to them that may have begun to cause friction, will materially reduce the number of occasions on which, in the view of either employers or employed, it is necessary to contemplate recourse to a stoppage of work.

"26. We venture to hope that representative men in each industry, with pride in their calling and care for its place as a contributor to the national well-being, will come together in the manner here suggested, and apply themselves to promoting industrial harmony and efficiency and removing the obstacles that have hitherto stood in the way."

The Report thus frankly recognizes the advantages of thorough organization of both labour and capital and encourages both employers and employed to organize—not, however, for hostile purposes but in order that they may effectively co-operate, after discussion and settlement of the conditions of the co-operation, with the national well-being as one of the central motives. And this was widely approved by both sides of British industry and adopted by the Ministry of Labour. What a change of ideal from the prevailing ante-war view of industry as a "jostling jumble of competitive firms, each attempting to secure advantage over its competitors or the public, by the demoralizing means of monopolies or unfair privileges, but each exploiting materials and men for private gain"!

"Political democracy was greatly advanced in Great Britain last year by the enfranchisement of 8,000,000 new voters. Industrial democracy has now started on its course with the historical document promulgated by the Ministry of Labour, which may be considered as its constitution. It undoubtedly has many rocks and shoals to discover, but that the right general course has been chosen there can scarcely be a doubt. This is by far the most interesting and far-reaching experiment in the improvement of industrial relations ever attempted in any country. When the history of Great Britain during the twentieth century comes to be written, the year 1917 will stand out as the date on which the Magna Charta of

Digitized by Google

industrial democracy was won—a date that may stand beside 1215 in importance. But one does not need to have a profound knowledge of history to recall that the great charter of political liberty, won seven centuries ago, was merely a starting point, a broad statement forecasting a freedom, much of which had to be struggled for in future and won bit by bit during a long period of time. 'The Bill of Rights', 'The Habeas Corpus Act', 'The Act of Settlement', the great Reform Bills, are a few outstanding milestones, marking successes in this long struggle. When the barons brought King John to his knees, long centuries had yet to elapse, a civil war had to be fought, a king executed, and many other struggles carried out, before the full rights of parliament were finally assured.

"Such facts as these should warn us against mistaking the forms of liberty for the reality. They should warn us, too, that the growth of real freedom is slow. The creation of parliament, the symbol of liberty, by no means meant that parliamentary liberty had been finally won. So now. These joint industrial councils and committees, these new symbols of industrial freedom, are merely organizations created for the purpose of winning and defining democratic freedom in industry. The long training in the orderly method of securing political liberty through parliament will, no doubt, prove of great value here. But while the new joint industrial councils and committees express clearly a general recognition that workmen have rights not yet obtained, including a right to share in the responsibility of defining them, the actual formulation and winning of these rights are in the future.

"It is, however, a great advance step that industrial civil war should end in the creation of the means for the orderly consideration, working out and definition of those rights, by the deliberate use of discussion on equal terms in the open, in place of under a constant threat of the exercise of might. Democracy has herein scored another great win. It is a long step forward in civilization when it is recognized for any new field that social progress (in this instance, in the industrial field) should be by a steady and orderly adaptation of social institutions and laws to changing conditions, under the action of free discussion and the pressure of public opinion thus created; and when it is further recognized that the primary condition of progress under such free discussion is such a flexibility and sensibility, combined with such an efficiency, of organization in our representative institutions, as will make the conclusions reached by these bodies a true generalized expression of the best opinion they are intended to reflect. How to combine this sensibility to the

Digitized by Google

best real opinion with a stability that will ensure a steady ship making progress on a true course, a ship that does not rock with every temporary wave of opinion nor drift with every current and breeze of social theory that impinges on it, is a problem whose solution has been fairly successfully worked out by long experience in political democracy. Much careful thought and probably some disappointing experiments will be required before an equally successful combination of checks and balances is secured in industrial democracy.

"But industrial democratic methods must surpass political methods in efficiency, which has always been their great weakness. Let us admit, once for all, that cumbersome machinery causing inefficiency cannot, and will not, be tolerated by either masters or men in democratic industry. If democracy in industry has to be won at the cost of efficiency in the highest sense, then it will prove not an assistance, but a hindrance, to social progress. For it must be recognized as an economic axiom that the greatest social advance can be obtained only on the basis of the most efficient production of those goods and services necessary for the satisfaction of human wants. Only a high degree of efficiency in economic service of all kinds, rendered by all in proportion to the ability of each, together with a fair and just distribution of the wealth thus produced, can secure a high standard of life for every one, act as incentive to every one to bring to bear his best efforts and ensure at the same time that leisure for social welfare and self-improvement on which the progress of human society depends.

"But I have no hesitation in expressing the opinion that the full application of the principle of democracy to industry will prove to be the most successful experiment in increasing efficiency in the truest sense yet tried. For I have more than a suspicion that efficiency experts, so self-styled, have had their attention so engrossed by the study of microscopic details that they have missed altogether their main principle, the very foundation on which any true theory of efficiency must be built. They have become so enamoured of the stopwatch and statistical method that they have ceased to look around them at the broad facts of human nature lying patent to all. Expert observation is always dangerous because it implies limited observation. The greatest resource in industry, till now remaining almost untapped, is the human will, the fountain-spring of all conscious human activity; and the greatest present industrial inefficiency and loss results from conflict of wills. If the full response of the human will can be secured for any enterprise or any purpose whatever, the entire ability of the individual is available. Without this,

Digitized by Google

there may be reluctant, inefficient activity, drudgery; with this, there is the joy of creative work, a calling into play of the entire physical and mental resources of the individual, to an even greater extent than he himself is aware of. The former wearies, while accomplishing little; the latter rejuvenates, while producing much. Students of conservation and students of efficiency, which should be merely a department of conservation, have not given this fundamental principle the attention it deserves. In England, unskilled women, having the will to do their best for war purposes, have doubled, trebled and frequently quadrupled the output of skilled men working under conditions of pre-war reluctance. Have you never seen equal results under a favorable contract system? If we could, by a single stroke, tap this resource to the full the day the war ceases, the incalculable war debts of all the belligerent nations would quickly melt away, there would be produced an abundance of all necessary goods and services for everyone and there would be abundant leisure for enjoyment and improvement. It is this paralleling of human wills that is the core of the problem of the 'democratization of industry'.

"This expression, 'the democratization of industry', does not, as some may fear, imply a condition of semi-anarchy, weak organization and uncertain discipline. It is a form of organization suited for, and possible of effective use by, only the highest type of civilization, it is impossible for a poorly developed type—a fact remarkably illustrated at this moment by conditions in Russia. Democratic civilization is a living, growing type; one whose fundamental principle implies the assimilation, into the organized mind, of the best opinion of its members; a type that has the organization and adaptability to external conditions produced by vitality; a type whose aim is perfect development, not mere bigness and power; a type whose growth is from below upwards, whose guiding principle is, 'of the people, by the people, for the people'; not a type proceeding 'from the top downwards,' hence artificial, rigid, inflexible, incapable of true growth or development to meet the highest human needs; the antithesis of the type super-imposed by might, whose ruthless principle is the 'blood and iron' trampling under foot of the rights of all when in conflict with an autocratic will. The democratic principle applied to industry means vastly increased, not lessened efficiency. High industrial efficiency results from a number of conditions among which are thorough organization and cheerful discipline. Every intelligent workman knows this as well as you do. Intelligent workmen, unless disaffected, feel pride in efficiency and dislike anarchy. The prime cause of the wide-spread disaffection that has existed is exactly

Digitized by Google

those autocratic conditions which the democratizing of industrial relations will remove.

"Industrial democracy merely demands that all the conditions of the co-operation of labour and capital in industry shall meet with the approval of both parties. Is there anything unreasonable in this demand? With the two parties, each vitally and equally interested, is it unfair? If the demands of capital are just, surely it is only right and can do no injustice to anyone to discuss its claims in the open. If the fear of capital is that labour cannot understand the economic questions involved—a view that is probably true to a great extent at present—capital has itself largely to blame, for it has had the greatest say in framing the educational policy of the times. The 'Whitley Scheme' will bring about a discussion on equal terms of all the conditions of co-operation of capital and labour. After many of the minor questions have been satisfactorily settled, inevitably, the question of the just distribution of the joint product of the co-operation will come into the discussion. Ever since the first parliament met many centuries ago, this has been in the lap of the future. It is now within measurable distance. It may happen to-morrow. It is for capital to decide quickly what it is going to do about the question. Neither you nor I created the issue. But we are wanting in intelligence if we do not recognize what is inevitably ahead. What a world pity, it it turns out that labour has not the breadth of view, or has any lack in the sense of responsibility, necessary for dealing with this vital question! What a world pity, if, in the trying days ahead of us, labour undertakes to deal with this question, without adequate knowledge of sound economics and social ethics, as a ballast; what a pity, if, in place of such sound and sane insight into these vital matters, which ought to be as universal as general intelligence, labour has been left to the mis-guidance of half-baked, utopian, social theories, picked up from a cheap sensational press or from irresponsible but interested, agitators! And in political government in Great Britain, too, with the very large labour vote, labour will be in position to enforce its demands. And let us not forget that Great Britain is blazing a trail which Canada must soon follow. It is up to us to prepare for like conditions in future by training all our on-coming citizens to exercise intelligently these increasing powers, with their implied responsibilities. This we can most quickly and most efficiently do by a sound social training in all our educational institutions, whose courses of study and methods should be adapted without delay to meet the rapidly increasing social (including economic) exigencies of the times. Though the task

Digitized by Google

is herculean and the need urgent, there is apparently no widespread, clear discernment of its urgency. No reconstruction scheme of greater importance or of more far-reaching consequences could be undertaken at the present moment. Clear general enlightenment on economic and other social questions is the only safe course, if our social evolution, under the influence of the profound social changes now in rapid progress in Great Britain, is to be orderly and progressive. Failure to acquaint ourselves with, and to adapt our institutions to meet, these conditions may spell disaster. Nor is it a question of whether we like it or not. Within the past few months this mighty stride forward in Great Britain has been made. Even had we the desire to do so, we could no more stay this onward social movement, than could Canute the in-coming tide. But we can prepare for it, and it is our highest duty to do so, with no unnecessary loss of time.

"It is not natural to me to be sensational or to be an alarmist. I am merely following a sense of public duty in stating these matters as they appear to me. But that this account is not a mere exaggeration of the quiet revolution that has taken place in England within the past few months, may be gathered from the following quotation from a speech by Lord Salisbury before his fellow peers. Referring to the workmen, who had saved the country on the battlefields of Europe, and who have now at home, as he put it, 'to work out their own salvation, they will', he said, 'make many mistakes. Very likely they will adversely affect the property of many of your lordships. All these things are small matters. I earnestly hope that they will believe in us. I am quite sure that in the long run their good sense will prevail. But, whatever happens we intend to trust them, my lords, and I believe that they will return the trust.' What an eloquent surrender! The greatest victory of the British armies in Europe is the victory of industrial democracy, thus fully admitted.

"Some of the ideals set before itself by industrial democracy may now briefly be summarised: If the capitalistic system is to remain, it must gradually be so reconstructed as to bring greater equality in status, in wealth, and in opportunity as between capital and labour. Further, it must never be forgotten that the State, the organized public, is a partner in all business. . . . The system of unlimited wage competition has been proven a failure. It has reduced great numbers below any possibility of maintaining a decent standard of life. The best solution for this difficulty may not have been found. But social enlightenment, a strong desire to find such a solution as will be both just and

Digitized by Google

efficient in its results, and the opportunity for unreserved discussion under the new joint councils and committees, will find the true principle. In the meantime there can be no serious mistake in adopting, as quickly as practicable, at least temporarily, the principle of the 'living wage'.

"We have in this new organization a frank recognition of the benefits derived from thorough and universal organization of labour on democratic principles. We have similar recognition of the benefit to be derived by the co-operation of employers. The acceptance of public service as the chief incentive for seeking high industrial efficiency may be yet in the distant future. The need of this higher incentive to replace the old incentive of private gain may be obscured by the many relatively minor matters immediately pressing. But the evolution of a still wider joint council—a national council to represent every industry—an industrial parliament of national scope—with the purpose of co-ordinating all industrial endeavour so as efficiently to meet social and national needs, would seem to be the next logical step forward. Can we estimate the advantage to the nation such a complete national organization of industry would have proven to be, had it been in existence when the crisis came in 1914? This spirit of public service in place of the selfish desire for private gain, as a guiding principle in business, as the true motive power of all industry, must be of gradual growth. Probably to a greater degree than one would suspect many already feel it as a ruling motive. It will require many a long year before the majority of men will act on the principle that their obligation to service is measured only by their ability—whether that ability consists in capital, intellect, or manual dexterity—to perform such service; before they will realize clearly that true ethics demands that every man be a servant precisely in those matters of which he has the most intimate knowledge and in which he has attained the greatest proficiency. 'In a true democracy, we are all masters in respect to the interests of the community as a whole and servants in respect to our own special abilities'. Our greatest mistake so far has been in considering industry as somehow outside of democracy. . . . . How supremely important it becomes that for the exercise of the great responsibilities of citizenship in a democracy—whether political or industrial—every individual should definitely be prepared! The 'Whitley Scheme' is a remarkable step forward in democratising industry, but, if its benefits are to be realized in reasonable time, it must be backed up by such general economic and ethical enlightenment as shall make clear to the mass of the population, and not merely to a few, the high ideals that inspire it and the most practic-

Digitized by Google

able means for attainment of them. This is the minimum technical preparation necessary for efficiently operating the most delicate, but powerful, democratic machinery yet constructed."

In the world's history, the industrial epoch on which we are now well entered, has raised the most complex questions as to social and political relationships the human race has so far had to face. Unfortunately there are kaisers in industry just as there have proven to be in politics. The inevitable result in both cases has been war—in the one case for social and industrial freedom, and in the other for political freedom. Only enlightenment can create the co-operative, constructive spirit. But the enlightenment must be such as discriminates the large from the small, the principle from the detail, wisdom from mere knowledge. When, at last, we acquire wisdom as well as knowledge, we shall see that our industries exist for the benefit of all the people and not of the capitalist mainly; we shall see that the individual welfare can best be taken care of by caring for all; we shall see that capitalist and workmen are as interrelated as the parts of the human body; that neither is servant of the other, but that each is both servant and master; that we cannot injure the one without injuring the other; that we have here one of the highest problems the human mind has set itself to solve; that the best combined wisdom of all will be required to work out the best progressive solution of this greatest of industrial problems; that no solution of a problem of this nature will be final except in principle; that this is only one of those adjustments of human relations which must be continuous with the evolution of human society. When men have arrived at this broader view, they will become reasonable. We are safe in saying that centuries may be required in working out the solution to the industrial problem, since this is merely a problem in social evolution. Social evolution is the continuous adjustment of social relations to meet changing conditions. As long as these change, we must have the problem with us. It is easy to adjust the parts of a machine. But when each part is itself infinitely complex—is in fact a human being, whose adjustment in industrial relations must be self-adjustment—it is self-evident that any real mitigation of industrial ills must be founded on the gradual growth of intelligence and ethical feeling.

Digitized by Google

THE GROWTH OF THE SCALES IN FISHES.

BY A. G. HUNTSMAN, B.A., M.B.,

Biologist to the Biological Board of Canada.

INTRODUCTION.

Like many other branches of science, the study of the scales of fishes practically began with the nineteenth century. At the beginning of that century they were investigated almost entirely from the standpoint of their use in classification, as shown in the works of Heusinger (1823), Kuntzmann (1824), and Agassiz (1834). This aspect of their study has been revived in the present century by Cockerell in a series of papers, in which he has shown their great value in this direction.

There naturally followed a desire for more accurate knowledge as to their structure. This led to researches chiefly by Mandl (1839), Williamson (1851), and Baudelot (1873). The question of their mode of development likewise came into the foreground. It was noticed by Vogt (1842) in his study of the development of the salmon, but the first important contribution to the subject appears to be that of Klaatsch (1890), and following him it forms the entire subject of a paper by Ussow (1897).

Only at the end of the century do we find attention turned to the value of the scales in the study of the age and life history of fishes. Hoffbauer (1899) revived and critically investigated for the carp an old view, originated by Leuwenhoeck (1685) for the eel, that rings to be seen on the scales indicate the age of the fish. It has led in the present century to a long series of papers applying this interpretation in the investigation of the life histories of the majority of the commercial fishes. It is to be understood that we are referring principally to the group of the Teleosts or bony fishes, among which are to be found nearly all the commercial species.

Digitized by Google

STRUCTURE AND MODE OF GROWTH.

The scales of bony fishes are situated in pockets or sacks of the dermis, and are covered by the usually thin epidermis. They are arranged more or less regularly and symmetrically in longitudinal and oblique rows. If at all large they overlap each other from head to tail like the shingles on a roof. They vary greatly in shape and texture, but are usually round, thin plates, with considerable flexibility and toughness, though at times thick and heavily calcified.

A scale consists of two chief parts. There is an outer thin, quite homogeneous layer of so-called hyalodentine, the surface of which exhibits the sculpture characteristic of the kind of scale. The inner part is much thicker and can be split into layers, which was first observed by Leuwenhoeck. Mandl showed that each layer consists of many fine fibrils. In any layer the fibrils run for the most part parallel to each other, but those in successive layers cross each other and so strengthen the scale.

The outer surface of the scale (see Figure 2) shows two regions, anterior and posterior, separated in the herring by a base line. The larger *anterior field* is to a great extent covered while in position by the scales in front. The *posterior field* is the part that is evident when the fish is observed. In the middle of the scale at their boundary is the *focus*, which is the point of origin of the scale.

The sculpture appears as two series of lines. The more numerous and most closely placed lines are projecting fine *ridges* of hyalodentine, which are inclined slightly toward the focus. They are usually arranged concentrically to the focus and for that reason Cockerell has given them the name of *circuli*. In the herring they are almost transverse, except in the scales of the back, as described by Paget and Savage (1916). They are more distinct in the anterior field and are frequently confined to that region.

The second series of lines is due to the presence of *grooves* in the outer layer, the hyalodentine being deficient. In the herring at least the lines remain in part when the outer layer and some of the outermost fibrous laminae have been removed, there being some peculiar material, the nature of which does not seem to have been shown, along these lines in the inner fibrous layer. The grooves usually radiate from the focus, and they have therefore been called *radii*. But again in the herring they are almost transverse in the anterior field, except in the scales of the back, where they are longitudinal, and in the posterior field they are, if present, only slightly developed.

Digitized by Google

Two views as to the manner of growth of scales were held in succession by Leuwenhoeck. His first view, which he afterwards abandoned, was that the scale grew by additions along the margin. Later he believed that increase occurred by the addition of new layers to the inner side of the scale, each layer being larger than the one preceding. Subsequent investigations have shown that both methods are involved. The outer layer of hyalodentine increases by the formation of new material along the margin of the old, whereas the inner fibrous layer grows by the addition of successively larger laminae on the inner side of the older laminae.

MATERIAL AND METHODS.

The following kinds of scales have been used in this study. Their positions in the herring are shown in Figure 1. A peculiar scale, situated immediately behind the suboperculum of the gill-cover, may be called the "*branchial*" scale (Figure 1, b). It was used by Lea (1910) in his

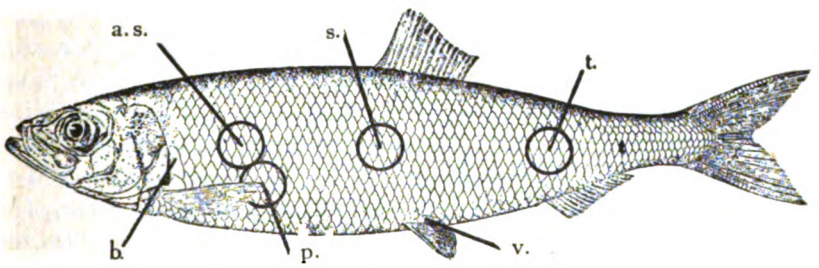


FIG. 1. *C. harengus.* a.s. "anterior side" scales. s. "side" scales. t. "tail" scales. b. "branchial" scale. p. "pectoral" scales. v. "ventral" scale.

investigation of the comparative rate of growth of scales and body. Another scale, which is peculiar and easily recognized from its long, narrow shape, is to be seen at the base of the ventral or pelvic fin, and may be called the "*ventral*" scale (Figure 1, v). To the scales in the region of the tip of the pectoral fin, when it has been flexed backward along the side and parallel to the long axis of the body, the name "*pectoral*" scales may be given (Figure 1, p). To those in the middle of the side at about the seventh vertical row behind the gill-opening, the name "*anterior side*" scales (Figure 1, a.s.). To those in the middle of the side below the anterior part of the dorsal fin, the name "*side*" scales (Figure 1, s). And to those in the middle of the side above the front part of the anal fin, the name "*tail*" scales (Figure 1, t).

Digitized by Google

The dimensions that have been measured in determining the growth of the scale are as follows:—(1) The greatest dorsoventral or transverse diameter, V (Figure 2, V); (2) the anteroposterior or long diameter, W (Figure 2, W); (3) the anteroposterior diameter of the anterior field, X (Figure 2, X); and (4) the anteroposterior diameter of the posterior field, Y (Figure 2, Y). These have been measured under a binocular microscope with a glass scale graduated to fifths of a millimetre.

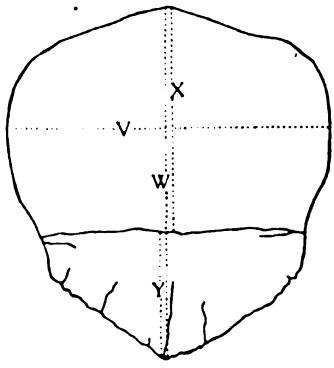


FIG. 2. *C. harengus.* "Side" scale, showing dimensions.

As it has not been feasible to study the rate of growth of the scale through equal intervals of time, the total length (L) of the fish has been taken as the standard of growth and the scale compared with it. It is this relation (diameter of scale to length of body) that is of most importance for the use of the scales in the study of the life history of the fish.

Four species of fishes have been used, (1) herring (*Clupea harengus*), obtained in the Bay of Fundy, except a small number from Souris, P.E.I., (2) ale-wives (*Pomolobus pseudoharengus*), taken in Lake Ontario at several points between Hamilton and Toronto, (3) cunners (*Tautogolabrus adspersus*), caught in St. Mary bay, N.S., at the mouth of the Bay of Fundy, and (4) flounders (*Pseudopleuronectes americanus*), from the St. Croix river, N.B., and the Annapolis basin, N.S. The total length (L) was measured on one of the usual boards, giving the length to the nearest centimetre. In a number of cases, chiefly small individuals, the measurements were made to millimetres.

SCALES AS INDICATIVE OF THE LIFE HISTORY.

The presence of definite seasonal markings on the scales, the most definite of which are the "winter" rings, has made it possible not only to determine the age of the fish, but also to deduce the amount of growth during each year of the life of the fish. This latter use is dependent upon a certain correlation in growth between the scale and the whole fish. For it we are indebted chiefly to Lea and the other Norwegian investigators. They have achieved brilliant results in their studies of the scales of fish, particularly of those of the herring. As a preliminary to the use of the scales in calculating the amount of growth in each year

Digitized by Google

of the life of the fish, Einar Lea (1910) made a series of measurements of the "branchial" scale in herring of ages ranging from one to twelve years. He measured the long diameter, which happened to be the dorsoventral (V). He found that the ratio of the total length of the fish (L) to the length of the scale (V) decreased slightly with age, but that the ratio of the length of the scale-covered area (T), measured from the posterior edge of the gill cover to the commencement of the median caudal fin ray, to the length of the scale was practically constant. He therefore rightly concludes that the scales may for practical purposes be considered to grow uniformly with the fish. "And as we can see from the scale's growth-zones how large it was at the different periods of development, so we can make deductions regarding the size of the herring at its various periods of growth with an accuracy that is limited by the individual variability in the ratios $\frac{L}{V}$ and $\frac{T}{V}$."

This method of investigating the life history of fishes has proved of very great service, and is being used by an increasing number of workers for many species of fishes. It is only natural that there should be a desire to critically examine the basis of such a valuable method. There have been more than one expressions of the opinion that the correspondence in growth between the scale and the body is not absolute.

Milne (1913, p. 584), in using this method on salmon that had been marked as kelts and after an interval recaptured, found that in one case the calculated length for the kelt period differed by only three-quarters of an inch from the actual length, but in another case the difference was nearly six inches. He also found a lack of agreement in measurements from different scales of the same fish, and does not think that the scales grow quite equally.

Winge (1915, p. 11) has determined for four specimens of codfish the relation in growth between the scales and the whole fish. These fish had been marked and recaptured after an interval during which a variable amount of growth occurred. He finds a very close correspondence in growth between the scales and the whole fish. As none of the fish were small, this is not surprising. The principal discrepancy is to be expected in the early stages. His results are, however, interesting from a standpoint which he has not considered. His calculations are based on seven scales from each fish. The smallest cod grew from 31 centimetres to 43. The scales on the average grew proportionally more than did the whole fish. For the other three cod the increase in length was from 40 to 45 centimetres, from 40 to 51 centimetres, and from 43 to 66 centimetres respectively. In each case the scales grew propor-

Digitized by Google

tionally less than the whole fish. These results indicate a definite change in the growth of the scale relative to the growth of the fish, namely an early more rapid and a later less rapid growth. This is similar to what I have found for other fish by a different method.

Taylor (1916, p. 314) in studying the squeteague (*Cynoscion regalis*) discovered "the possibility of a slight error" in the calucaltions. "In fishes of 4 or 5 cm. in length the scales do not overlap, but must grow proportionately more rapidly than the body in order to do so. In addition to this, it is also noted that the proportion of the exposed part to the unexposed part is constantly diminishing, indicating a more rapid growth of scales than of the body. Hence, the proportionate distance apart of the several annuli does not represent the correct proportion of growth of the fish. This is probably compensated for by the late appearance of the scales. The fish is from 3 to 4 cm. long before any scales appear."

While working with Dr. Johan Hjort on the scales of the herring during the winter of 1914-1915, I noticed in some very young herring that the scales were quite evidently proportionally small. They did not overlap, nor were they as long as the widths of the subjacent myomeres. It seemed certain, therefore, that during early life at least the scales do not grow at the same rate as the body. The investigations of Vogt, Baudelot, Klaatsch, Ussow and others on the development of the scales have shown that they appear only after the fish has attained a length of from two to four centimetres. This would not invalidate their use in length-calculations, provided they attained before the first winter a certain relation to the body length, which would subsequently be maintained. Lea had apparently shown that such was the case. Preliminary measurements of "side" scales indicated a progressive change in the scale-body ratio similar to Winge's results for the cod. The weakest link in Lea's chain of argument appeared to be the tacit assumption that all dimensions of the scale increase at the same rate. The problem resolved itself into the determination of the relation to the body length during growth, in different species, of scales from different regions, and of various parts of the same scale. Lea's method has merely been extended. The only feasible method, therefore, has been to measure the selected dimension in a large number of fishes of each size taken at random.

Clupea harengus—HERRING.

The dimensions investigated for the herring are (1) V on the "branchial" scale, (2) W on the "ventral" scale, (3) X and (4) V on the "side" scales. In the last case a definite scale could not be selected,

Digitized by Google

therefore a number of scales from the region were taken and the average value of the dimension for these obtained. This region was chosen because its scales or similar ones are ordinarily used for study and length calculation and because the scales are comparatively uniform. Lea has shown (1910, Figures 3, 4, and 5, p. 11) that in longitudinal series along the middle of the side the scales are comparatively uniform between the 18th and 25th vertical rows, and I have obtained a similar result. I have also measured vertical series across this region in two herring, 17 and 17.2 cm. long respectively. From three to five scales were taken from each longitudinal row in a band from the ventral surface to the dorsal, the dimension X measured and the results averaged for the scales of each row. These averages have been plotted in Figure 3. The longitudinal rows from the fourth to the tenth inclusive show a comparatively uniform value for this dimension. Below the fourth and above the tenth the dimension decreases as we pass to the ventral and dorsal surfaces respectively.

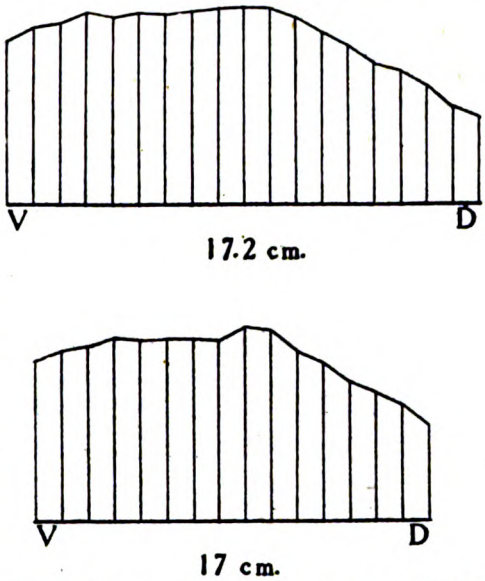


FIG. 3. *C. harengus.* Relative values of dimension X in scales in a vertical row from ventral side (V) to dorsal (D).

That scales from this region are not very variable is shown by the following. The variation in the ratio $\frac{L}{V}$ for the "branchial" scale may first be determined. Lea's measurements for 109 variants in fish from 103 to 183 mm. long (1910, pp. 26 and 27) give a mean value for $\frac{L}{V}$ of 29.5 ± 0.1, a standard deviation of 1.646 ± 0.075, and a coefficient of variability of 5.58% (± 0.28). Our measurements for 39 variants in fish from 100 to 185 mm. long give a mean value for the same dimension of 27.65 ± 0.22, a standard deviation of 2.00 ± 0.15, and a coefficient of variability of 7.25% (± 0.56). This indicates that our material differs from Lea's in the value of this dimension and also that our material is more variable. This was to be expected, since Lea's material consisted of winter-caught Norwegian spring herring, which appear to be quite

Digitized by Google

homogeneous, whereas our material has consisted of an apparent mixture of spring- and fall-spawned herring from the Bay of Fundy, caught at various times throughout the year.

For 15 variants in fish from 155 to 164 mm. long as given by Lea, the ratio $\frac{L}{V}$ has a mean value of 29.25±0.24, a standard deviation of 1.39± 0.17, and a coefficient of variability of 4.75% (±0.59). For 18 variants in fish with the same range in length we have found the ratio $\frac{L}{X}$ in the "side" scales, when the average value for X in a number of scales from each fish had been taken, to have a mean value of 52.83±0.41, a standard deviation of 2.57±0.29, and a coefficient of variability of 4.87% (±0.55). In all 138 scales were measured in these 18 herring. If the scales be considered separately, we have 138 variants for the ratio $\frac{L}{X}$, with a mean value for it of 53.38±0.19, a standard deviation of 3.32±0.13, and a coefficient of variability of 6.22% (±0.25).

Although this consideration of the question is not exhaustive, it indicates quite clearly that the "side" scales are not more variable than the definite "branchial" scale, in the dimensions considered. In spite of the fact that our material for each size has been of different ages and presumably from different races of herring, the variability in the ratio $\frac{L}{X}$ in the "side" scales is little greater than that of the ratio $\frac{L}{V}$ for the "branchial" scale in the homogeneous material considered by Lea.

"Branchial" scale.

The few measurements made of the dimension V in the "branchial" scale are given in Table 1. They are in agreement with those of Lea in showing a decrease in the ratio $\frac{L}{V}$ with increasing age. The 39 measurements in herring ranging from 100 to 195 mm. in length give an average value of 28.1 for the ratio, whereas the 19 measurements in herring ranging from 284 to 365 mm. in length give an average value of 25.8 for the same ratio. The single measurement in a very young fish, 51 mm. long, is somewhat doubtful, owing to the difficulty in picking out the scale. It, moreover, does not agree with the result of 10 observations made by Lea in small fish, which is given in a manuscript kindly communicated to me by Dr. Hjort. Lea's average value for herring about 4 cm. long for $\frac{L}{V}$ is 1.25 mm. This gives a value for $\frac{L}{V}$ not much greater than that in older fish. For lack of more material of the younger stages, the study of this dimension has not been carried further.

Digitized by Google

"Ventral" scale.

Measurements of the dimension W of the "ventral" scale in 84 herring from 48 to 365 mm. long are given in table 2. For this dimension, as well as for the preceding, the scale has been taken from the right and left sides indifferently, and in many cases both right and left scales have been taken. That this is a matter of indifference is shown by the fact that in 39 herring from which both right and left scales were obtained

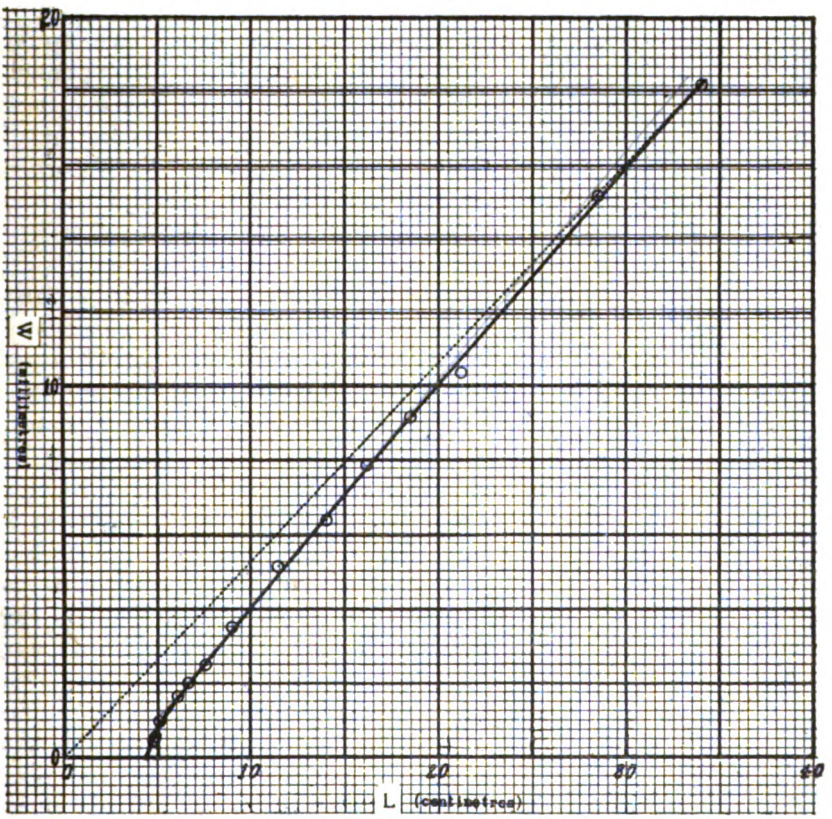


FIG. 4. *C. harengus.* Relation of "ventral" scale length (W) to body length (L).

and distinguished in measuring, the average value of W for the right side was 9.806 mm., and for the left side 9.798 mm. There is seen to be a decrease in the value of $\frac{L}{W}$ during growth. This is at first very rapid, but in later stages extremely slow. This is more evident if we summarize the data by arranging all those above 80 mm. in length in groups, each

Digitized by Google

with a range of approximately 25 mm. The average value of $\frac{L}{W}$ for each group is determined, and the average value of W therefor in the case of the body-length midway between the two extremes in the group is calculated. This summary is given in Table 3. The data therein are shown graphically in Figure 4, W being plotted against L. The continuous line represents what may be considered the normal change in the value of W during growth, compared with L. A constant value for $\frac{L}{W}$ would necessitate that this line be straight and originate at 0. Such is represented by the dotted line. The continuous line shows an early rapid increase in W and a subsequent steady increase in the same. Having a number of observations on quite small herring, in which the scale could be obtained with certainty, we have been able to fix the character of the first portion of the curve more definitely than has been possible for the "branchial" scale. If comparisons are justifiable with such scanty data, it would seem that the curve for V of the "branchial" scale (not shown) is more convex in its first part than that for W of the "ventral" scale. In other words the "branchial" scale attains at an early stage a larger proportion of its final ratio to the body-length than does the "ventral" scale in the dimensions considered. We have, however, to do with a different dimension as well as a different scale. Both scales are quite peculiar. The "branchial" scale results from the very early fusion of two adjacent scale rudiments in the first vertical row. It is, therefore, not surprising that its dorso-ventral diameter should be large in the earliest stage recognizable. The "ventral" scale, on the other hand, has an unusual anteroposterior growth. In Figure 5 three stages in its growth are shown, all drawn to the same scale. They are from herring 53, 99, and 195 mm. long respectively. The radii are shown and the anterior field is shaded. The smallest shows no anterior field. In the second it occupies nearly half the scale, and in the third

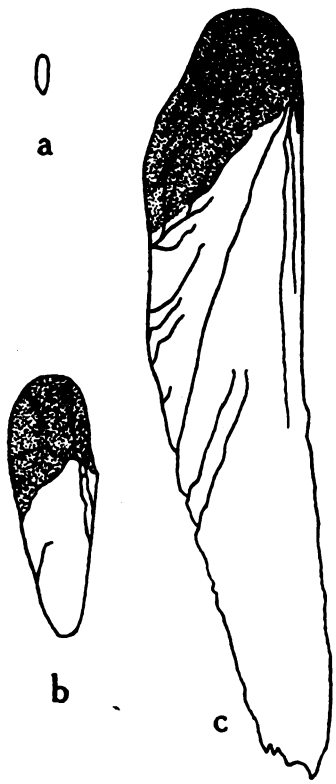


FIG. 5. *C. harengus*. "Ventral" scales. × 10. Lengths of herring from which they were taken: a, 53 m.m.; b, 99 m.m.; c, 195 m.m.

Digitized by Google

only about one-quarter. The anterior field appears later than the posterior, grows for a time more rapidly, and finally less rapidly. There is also a marked inequality between the dorsal and ventral halves of the scale in growth. In the smallest scale they are symmetrical. In the second the ventral half (on the right side) is less than one-half the width of the dorsal half, and in the third the inequality is still greater. The ventral side of the scale is in contact with the base of the fin, which doubtless prevents it expanding on that side. The growth is not altogether prevented, but, instead of broadening, that side forms a marked external ridge. Growth prevented in one direction turns to another.

The curve for W of the "ventral" scale, as in Figure 4, indicates that the scale appears when the herring is approximately 45 mm. long. In our material the metamorphosis of the herring from the larval condition occurs between the lengths of 45 and 50 mm. Meyer (1878, p. 244) gives the length during metamorphosis as from 32 to 45 mm. in the herring of the Schlei, and states that even at a length of 39 mm. many have completed the change and are fully scaled. The appearance of the scales, therefore, synchronizes with, and varies with the metamorphosis.

"Side" scales.

Two dimensions, X and V, have been measured for the "side" scales and our data for them are more extensive than in the previous cases. The dimension X is of particular importance, since it has apparently been in general use for length-calculations. The values for this dimension for 267 herring, from 45 to 364 mm. in length, are given in Table 4. As already stated, the average value for the dimension in a number of scales from each fish has been taken. The number of scales used in each case is given in a separate column. Where possible ten fish for each centimetre-group have been used. In Table 5 A there is given a summary of the data, and in Table 5 B a summary of additional data, not given in full. There is comparatively little difference between the two sets of data. They serve to show the probable accuracy of the figures. It will be seen that the value of the ratio $\frac{L}{X}$ decreases at first rapidly, then more slowly until it becomes approximately 50 at a body-length of about 22 cm. Subsequently it increases slightly. In Figure 6 this is shown graphically in the same manner as in Figure 4 for dimension W of the "ventral" scale. The size of the circles is intended to represent, though quite roughly, the general "probable error" of any determination of X for a centimetre-group. This error in several determinations varied from ± 0.035 to ± 0.065 mm. The continuous line represents the

Digitized by Google

change in value of X in relation to L during growth in a normal case. The dotted line indicates the condition that would obtain, if the ratio $\frac{L}{X}$ maintained throughout its lowest normal value, a condition that would make the usual length calculations accurate. It will be noted that the divergence from this is greatest in the early stages.

In spite of the numbers used some of the data do not fit as well as might have been expected into the curve that has been drawn. Of the factors that produce irregularities one may be considered. In collecting material one is apt to use as few lots as will give the necessary numbers of fish of each size. A lot of fish all of the same age, or approximately

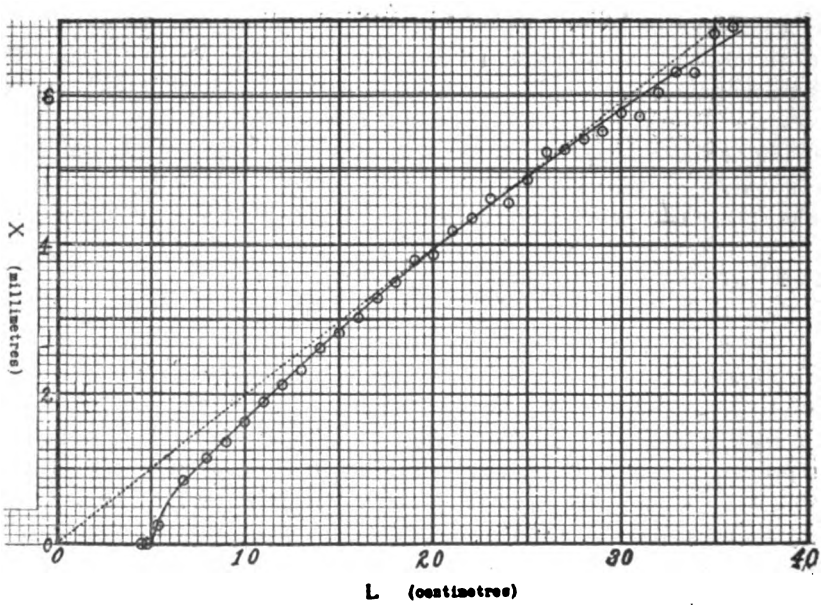


FIG. 6. *C. harengus.* Relation of "side" scale length (X) to body length (L).

so, will contain fish of different lengths. We might have, for example, in our data herring 11 cm., 12 cm., and 13 cm. long, all of the same age. The older the fish the greater the range in size. This is not random sampling. They will not be strictly representative of the groups to which they belong. Those only 11 cm. long taken from a group averaging 12 cm. in length will be older fish than the average for their size. We would expect them to have unusually large scales, as it is unlikely that there will be correlation between body and scale in retardation of growth. This is found to be the case.

Digitized by Google

Four herring of the 10 cm. group taken from a lot with an average length more than 10 cm. gave an average value for X of 1.71 mm., which corresponds to a value of 58.4 for $\frac{L}{X}$. Four fish of the same group taken from a lot with an average length less than 10 cm. gave an average value for X of 1.58 mm., corresponding to a value of 64.1 for $\frac{L}{X}$. The values for X and $\frac{L}{X}$ for the 10 cm. group, as obtained by supposedly random sampling and given in Table 5, are 1.63 mm. and 61.43 respectively. These values are almost midway between those given above for old and young individuals respectively.

This has been done likewise for seven old and seven young individuals between 13 and 14 cm. in length. No old individual had a value for X as low as the highest value given by the young. The averages are, older fish, 2.58 mm., younger fish, 2.29 mm.

If this factor were not excluded, it would make the part of the curve in which any definite age-group of various sizes predominated, more horizontal, raising the beginning of that part and depressing the end. The herring from successive spawning periods differ more in size during their earlier years than later and tend to be segregated in the former period. There is, therefore, more likelihood of the sampling not being at random in the case of the younger fish. There are evidences in the data of this factor having a slight influence for the early stages.

The first part of the curve is not symmetrical with the remainder. As in the case of the "branchial" and "ventral" scales, there is after the scale begins to grow a very rapid fall in the body-scale ratio. Later the fall is much more gradual. The data for this part of the curve are not as numerous as one could wish, but I believe that they are sufficient. It is to be expected that there will be some variation in the length of the herring at the time of appearance of the "side" scales, but it cannot be great enough to eliminate this asymmetry in the curve. The explanation of the latter is not difficult to find. The herring, as we have seen, undergoes a metamorphosis at the time of the appearance of the scales. The increase in volume at this period is more than the cube of the increase in length. The body becomes relatively much deeper. The length is, therefore, not a good criterion of the general growth. If the depth of the fish were used as the criterion of growth, the inequality in the first part of the curve would be smoothed out.

In its last part the curve differs from those for V of the "branchial" scale and W of the "ventral" scale in falling below the dotted line drawn from the zero point to the summit of the curve. That is, there is

Digitized by Google

latterly an increase in the body-scale ratio ($\frac{L}{X}$), or in other words the scale grows proportionally less than the body. The irregularity of the data increases with increasing age. For this reason the last part of the curve may be considered as less clearly established. However, if we consider the values for $\frac{L}{X}$ in the hundred herring from 17 to 26 cm. inclusive, we have for these a mean value of 50.80 ± 0.20. For the sixty-nine herring from 27 to 36 cm. in length, the mean value of the same ratio is 52.34 ± 0.20. The difference between the two means is nearly eight times the probable error in either case. It is, therefore, extremely probable that the high value of $\frac{L}{X}$ (and also the low value of X) in the older fish is significant. It may be maintained that it is due to some other factor than relative decrease in growth rate of the scale, such as the material not having been taken perfectly at random, but it is unlikely.

In each of the three kinds of scales, that we have considered, a different dimension has been chosen for a particular reason. This renders it uncertain whether the differences shown are due to the dimension or to the kind of scale. We have data for the value of the dimension V of the "side" scales in a series of herring, ranging in length from 48 to 363 mm. The number of individuals is not as great as for the dimension X. We give merely a summary of the data (see Table 6). The fish have been arranged in convenient groups, each with a range of not more than 36 mm. For each group the average value of $\frac{L}{V}$ has been obtained, a standard size taken (approximately equal to the average size), and the value of V therefor calculated.

There is a rather close correspondence between these results and those for the same dimension in the "branchial" scale, previously considered. In both there is to the last a decrease in the value of $\frac{L}{V}$ in that way differing from dimension X. This difference is to be ascribed, therefore, to the dimension and not to the scale.

The width of the "side" scales of the herring proportionally to the length of the body continues to increase throughout life, whereas the length of the anterior field at first increases and later decreases. The result of this is a change in the shape of the scale.

In Figure 7 are shown four scales of various sizes taken from the side of a herring larva 50 mm. long. They show the mode of appearance of the striated anterior field of the scale. It is absent in the smallest. On appearing it increases more rapidly than the posterior field and soon constitutes half of the scale. The part laid down previous to the appear-

Digitized by Google

ance of the anterior field forms the focus of the scale. The stages illustrated show that after a certain point all accretion to the scale on the anterior side is striated, and they give no evidence of any extension of the striation into the part of the scale laid down previously. This is in accord with Lea's observation from the structure of the scale that the outer striated part is increased only at the margin.

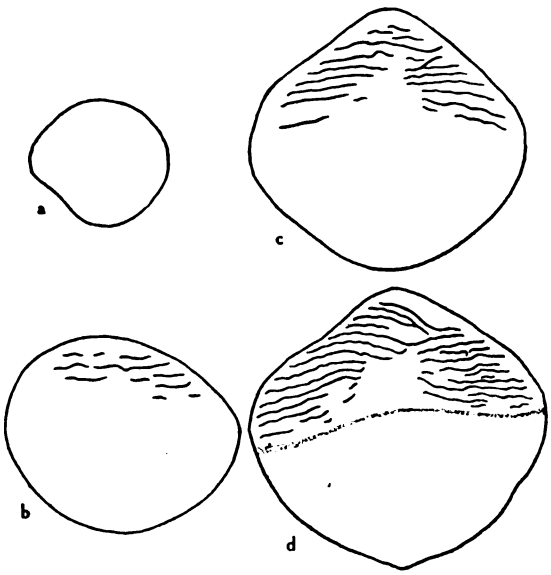


FIG. 7. *C. harengus*, 50 mm. long. Scales from side, × 50.

Figure 8 illustrates further the changes in the shape of a "side" scale, the smaller being from a fish 76 mm. long and the larger scale from one 301 mm. long. The anterior field ultimately forms the major portion of the whole scale. Its width becomes greater than that of the posterior field. These changes will be considered in greater detail for the next species.

Order of appearance of the scales.

In Figure 9 is shown the left side of a herring larva, 48 mm. in length. The side scales are seen to be just appearing. The relative sizes of the scales indicate the order of their appearance. The first place to acquire scales would seem to be a point along the lateral line between the anal and caudal fins. From this point the scaled zone extends predominantly forwards, more slowly backwards, downwards, and upwards. On the lateral line at the anterior end of the trunk is another point of origin, the extension therefrom being backwards, downwards, and upwards. This is the region in which the scales first appear in the trout, according to Klaatsch. Along the ventral side of the trunk between the pectoral and pelvic fins is a third region of this kind. Those in front probably appear first. This series ends in the "ventral" scale. This region extends very slowly upwards.

Digitized by Google

The last place along the lateral line to acquire scales is the region at the level of the anterior end of the dorsal fin, where the "side" scales are situated (unless it be the end of the tail, exclusive of the fin). The middle of the back is apparently the last region to become scaled.

Individuals both larger and smaller than the one figured show conditions which corroborate this view as to the order of appearance of the scales of the herring. The scales in a longitudinal series are less numerous than the underlying myomeres by one only. The longitudinal series first to appear on the side of the tail is immediately dorsal to that appearing at the anterior end of the trunk.

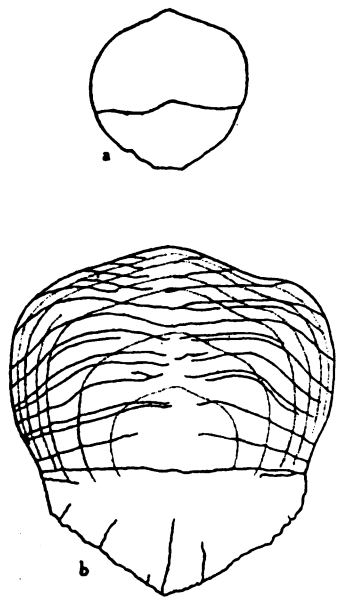


FIG. 8. *C. harengus*, (a) 76 mm. long, "side" scale, ×10; (b) 301 mm. long, "side" scale × 5.

The effect on length-calculations of the observed rate of growth of the scale.

In length calculations the "side" scales or similar ones are used preferably and the dimension, that we have called X, is recommended. Considering the curve given above for X to be correct, what effect will we find this mode of growth to have on the calculations of the length of a herring at each of the various winter periods in its life-history? The effect is not a simple one. Taking a hypothetical case of a herring 8, 15, 20, 23, 26, 28, and 30 cm. in length at the 1st, 2nd, 3rd, 4th, 5th, 6th, and 7th winter periods respectively, we have the calculated values for each winter period changing with the growth of the fish in the manner indicated in Table 7. These calculated values have been obtained by the use of Figure 6, dimension X having been presumed to show the normal size and growth. The method used may be illustrated by the following example. At the second winter the herring is 15 cm. long and the value of X is 2.87 mm. At the first winter the length is 8 cm., which gives a value for X of 1.15 mm. If scale and body grew at the same rate, 1.15 mm. would represent a length of 6 cm., when 2.87 mm. for X represents a length of 15 cm. for the body. In this case the calculated value is 25% less than the actual.

The changes in the calculated values shown are briefly these. The length at the first winter period decreases rapidly at first, then remains

Digitized by Google

stationary, and finally increases very slightly. For the second winter period the length decreases at first, remains stationary, and then slowly increases. For the third winter period the length is at first stationary and then slowly increases. For the remaining periods the length increases from the first, but more at the beginning than later.

The effect may be stated thus. Up to a length of 22 cm. the larger the fish becomes, the smaller is the calculated value for the length at any preceding period. Above a length of 22 cm. the calculated values for preceding periods increase with increasing length, the effect being greater on later periods than on earlier.

This factor is by no means negligible. Variations in the calculated lengths for definite winter periods have been noticed by several workers for a number of species of fish. Miss Rosa M. Lee (1912) has described what she terms the "phenomenon of apparent change in the growth

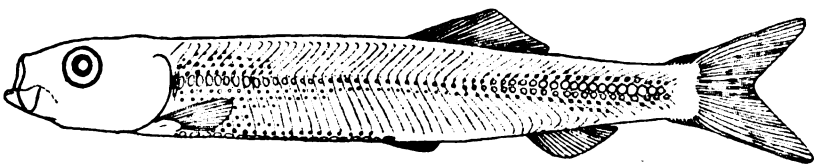


FIG. 9. *C. harengus*, 48 mm. long. Left side, × 2½.

rate" of herring, haddock and trout. The tables of length-calculations show that on the whole the older the fish investigated the smaller is the average calculated length for any winter period. She discusses several possible explanations of this phenomenon, but is rather inclined to the view that it is caused by a contraction of the scale. Fage (1913, p. 328) has found the same phenomenon in the pilchard (*Clupea pilchardus*). Lea (1913) analyses the material from the herring from the standpoint of the values of the yearly increments in length as calculated at different ages and defines the phenomenon in the following way. The first annual increments (1 to 3) decrease with increasing age. The succeeding increments (4 to 7) increase with increasing age. The last increments (8 to 11) seem to be constant. He proposes another explanation. "These differences are not due to methodical errors occurring in the material used. On the contrary they represent important features in the biology of the fish, viz., sexual development correlated to the growth, separation of the individuals of a year group in components of different sexual development and intermingling of these components in the course of time" (p. 35).

Digitized by Google

The factor considered by Lea is without doubt an important one. However, the change in the growth rate of the scale relative to the growth rate of the entire fish will account for a considerable portion of the differences between the observed and the various calculated values for any winter period. The irregularities in the data are too great for it to be possible to deduce the regular changes in the values with any great degree of accuracy. Also neither the dimension nor the kind of scale used for the calculations have been constant, so far as one can judge. It is desirable that a definite dimension of a definite kind of scale be taken and the lengths calculated therefrom corrected by means of the known change in the growth rate of that dimension relative to the growth rate of the entire fish. Whether this is feasible or not remains to be seen.

Meek (1916) also has reached the conclusion that there is "a want of correlation between the growth of the scale and the fish". He has however, deduced this want of correlation from the differences in the calculated values for the various ages, the explanation of which is the point in dispute. He gives, therefore, the same explanation of the phenomenon as we do in part. In Lea's manuscript, to which we have already referred, his argument is criticised adversely, and apparently with right. After finding from measurements that "it is plain that the scale expands proportionally to the length of the fish", Meek concludes from the discrepancies between certain calculated and actual values of the average lengths of herring for a certain year and, therefore, on theoretical grounds, "it is evident therefore that the scale does not grow exactly at the same rate as the fish".

Pomolobus pseudoharengus.—ALEWIFE.

Considerable material of the early stages of this species has been available, and this has made possible its utilisation in investigating a number of points connected with the growth of the scales. Young individuals were obtained in November of 1913 at Sunnyside, Toronto, and in October of 1914 at Burlington. These range in length from 2 to 8 cm. A single adult, 23.6 cm. long, from Port Credit has been studied. The small specimens are of the proper size to show when the various scales appear and the characters of the early part of the growth. The characters of their later growth can be little more than presumed from the condition of the scales of the single adult. The date are sufficient, however, to corroborate and extend the results that we have reached for the herring.

Digitized by Google

The scales appear at a length of about 2.8 cm., that is at a smaller size than in the herring. This corresponds with the smaller size attained by the adult alewife. It is a shorter, deeper fish than the herring. The order of appearance of the scales is practically the same as for the latter species. They appear in the following regions in order. (1) On the side of the tail along the lateral line at about the 43rd myomere, spreading predominantly forwards, also backwards, downwards and upwards. (2) On the ventral side of the trunk along the median line of the body anteriorly, spreading rapidly backwards, and very slowly upwards. (3) Behind the operculum and immediately below the lateral line, spreading rapidly backwards, less rapidly downwards, and very slowly upwards. The spreading of the scaled areas continues in the directions indicated until practically the entire trunk and tail are covered. The only change in this description to make it applicable to the herring is the substitution of 51st myomere for 43rd. This change is necessary because of the larger number of myomeres and also of lateral line scales in the herring.

As we are dealing in this species with a small number of individuals, it has been possible to compare several dimensions on the same kind of scale and also scales from different regions without unduly increasing the labour involved. The accuracy obtained is, however, of much lower degree than it would have been if large numbers of individuals had been used. The accuracy is, we believe, sufficient for the deductions that have been made.

Three regions have been selected. (1) "Anterior side" scales, situated near the lateral line at about the seventh myomere. (2) "Side" scales, as in the herring, situated near the lateral line below the anterior part of the dorsal fin. (3) "Tail" scales, situated just below the lateral line and above the anterior end of the anal fin.

Four dimensions have been studied for each kind of scale, V, W, X, and Y. The data are given in tables 8, 9, and 10. They are shown graphically in figures 10, 11, and 12, but the dimension W is not included.

The posterior or exposed portion of the scale, as judged by its antero-posterior diameter (Y), very quickly reaches a proportion to the body length that remains approximately constant throughout the remainder of the life of the fish. In the "tail" scales alone do we see a final increase in this proportion. We hesitate to consider this significant. The posterior field grows at the same rate as the whole body after the alewife has attained a length of about three centimetres. It is noteworthy also that this part of the scale grows at approximately the same rate in all

Digitized by Google

three regions. It is suggested that the length of the body exercises a control over the growth of the scale in this part. This may well be by virtue of the posterior field being the *exposed* portion of the scale. The length of the scale covered area of the body will determine the maximum total length of the exposed portions of the scales in any longitudinal row.

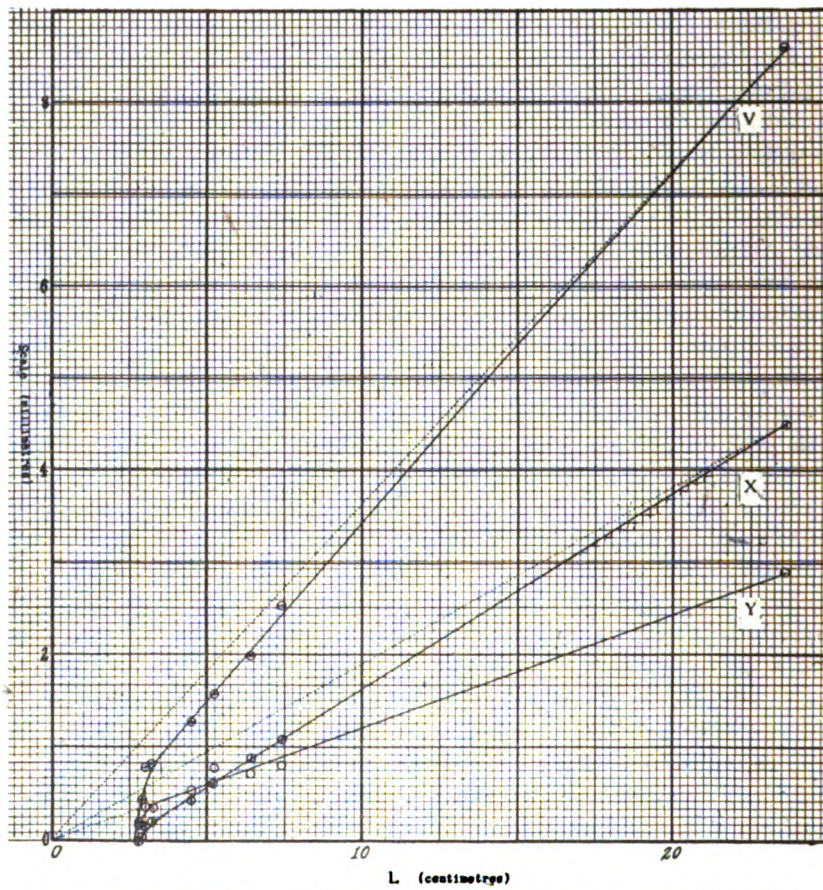


FIG. 10. *P. pseudoharengus*. Relation of "anterior side" scales (dimensions V, X, and Y) to body length (L).

The anterior field of the scale appears later, and, as judged by its antero-posterior diameter (X), continues for some time at least to grow proportionally faster than the whole body. Whether it in later stages grows proportionally more slowly, our material is inadequate to show. The "side" scales, which are the last of the three kinds to appear, show

Digitized by Google

the most regular growth. They do not at first increase proportionally to the body length as rapidly as the other two kinds, but their rate of increase continues undiminished for a longer period, so that a greater size is attained. This difference, we venture to think, is significant in spite of the small numbers involved.

The greatest dorsoventral or transverse diameter (V) of the scale in the early stages is in the posterior field, but later it is entirely confined to the anterior field. It is not surprising, therefore, that its increase

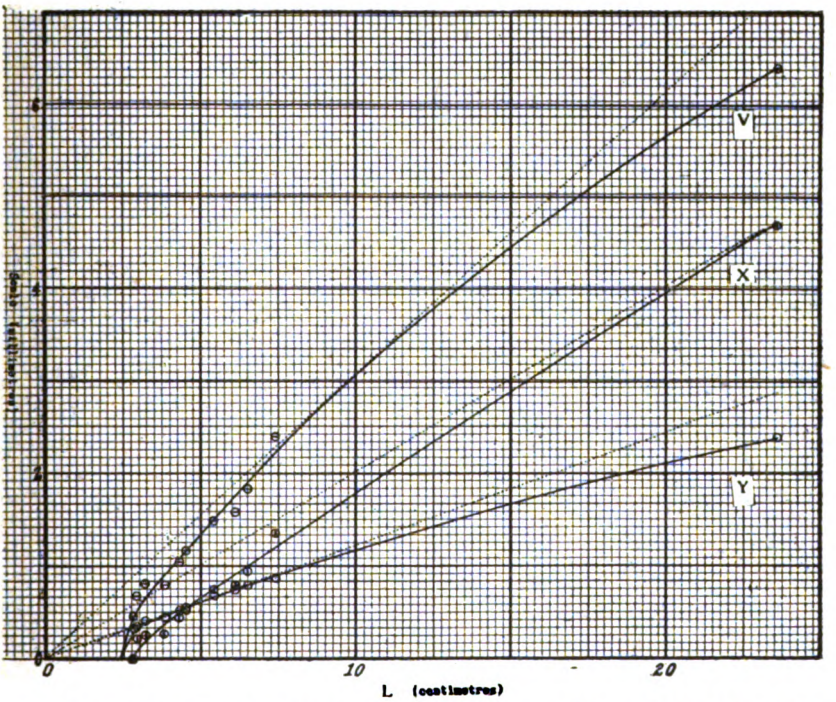


FIG. 11. *P. pseudoharengus.* Relation of "side" scales (dimensions, V, X, and Y) to body length (L).

shows characters intermediate between those of Y and X. Like Y it quickly attains a high value relative to the body length, but like X it continues to increase proportionally to the body length for some time. The reasons for these resemblances are obvious.

The later increase of dimension V shows differences, which are apparently characteristic of the several regions. In the "anterior side" scales the dimension would seem to increase proportionally to the body length throughout life, as has been shown to be the case for the neigh-

Digitized by Google

bouring "branchial" scale in the herring. Compared with this condition the "side" scales, and to a less extent the "tail" scales, show a final proportional decrease in this dimension. This involves the anterior field of the scale alone, and results in this region attaining distinctly different shapes in the three regions. This is shown in Figures 13, 14 and 15. This invalidates Cockerell's statement (1913, p. 124) that the scales of this species are conspicuously broader than long. It will be

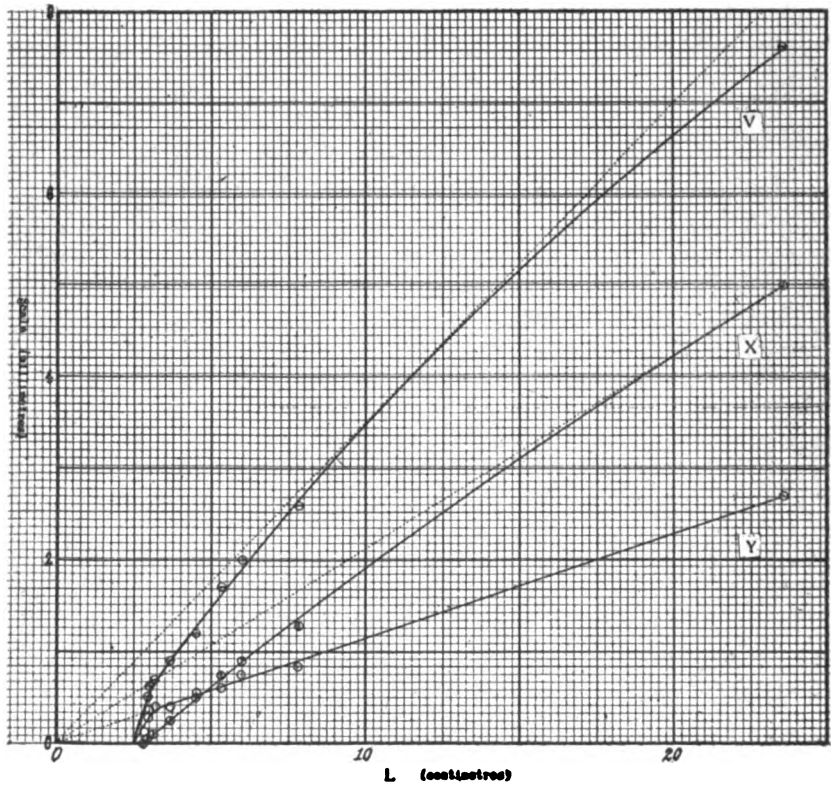


FIG. 12. *P. pseudoharengus*. Relation of "tail" scales (dimensions V, X, and Y) to body length (L).

necessary in characterizing the scales of any species to consider those from various regions.

In Figures 13 and 14 are shown "anterior side" scales and "tail" scales in various stages of growth. They are all drawn as they would appear if the fish were magnified to a length of 75 cm. in each case. They therefore show the changing relation in size of the scale to the

Digitized by Google

body-length, as well as the change in shape during growth due to the differential growth of the parts of the scale. As in the herring, the anterior field appears late but soon surpasses the posterior in size. It is evident also that the width of the "anterior side" scale continues to increase relatively throughout its growth, whereas that of the "tail" scale finally decreases.

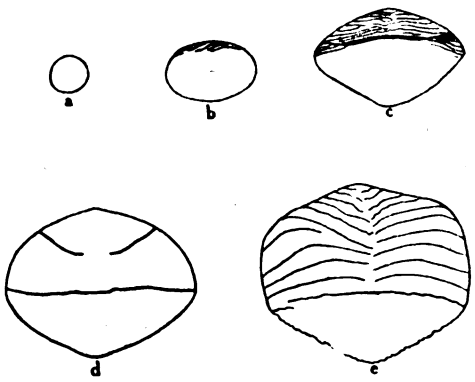


FIG. 13. *P. pseudoharengus*. "Anterior side" scales, as seen when body length is magnified to 75 c.m. a—28 mm., b—29 mm., c—30 mm., d—74 mm., e—236 mm.

That the growth of the anterior field of the scale is still more complicated than what has been revealed by the study of the two principal diameters, is shown by the condition of the radii, which are for the most part transverse in position. They are in large number in the older scales. Their course varies with their position. The most posterior radius is the base line separating the two fields of the scale. When it first appears (Figure 14,b) the ends are on the anterior margin of the scale and bend forward. When in older scales they become lateral, they bend backward. The latter condition holds during the greater part of the growth of the base line, which, as a result, in old scales describes a gentle curve with the concavity posterior. The slight anterior concavity due to the early growth is so small as to be indistinguishable in old scales.

The rule seems to hold, that a radius ending on the anterior margin is bent forward in its growth, and on ending on the lateral margin is bent backward. Those whose ends remain longest on the anterior margin have the largest anterior concavity. As an example of this, the seventh radius from the base line in Figure 15,b may be taken. Its ends still remain on the anterior margin. As we pass backwards from radius to radius the anterior concavity becomes smaller and smaller until in the base line we fail to perceive it.

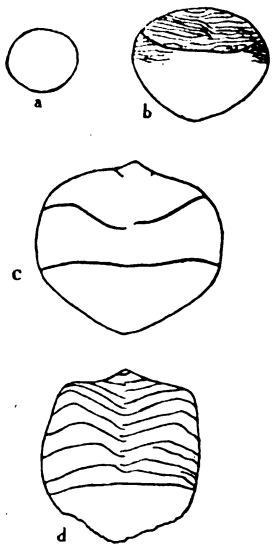


FIG. 14. *P. pseudoharengus*. "Tail" scales as seen when body length is magnified to 75 cm. a—28 mm., b—29 mm., c—74 mm., d—236 mm.

Digitized by Google

The size of the angle with the margin of the scale, which is made by the radius appears to depend upon the lateral growth of the scale. The less lateral growth there is, the farther are the radii bent back. The narrower "side" and "tail" scales have radii bent back farther than those of the broad "anterior side" scales. The circuli are influenced in the same way as the radii, but grow more strictly in a transverse direction while ending on the anterior margin of the scale, and are therefore interrupted by the radii. To a great extent they maintain the same position relative to the radii when bent backward on the side. A similar condition is to be found in the scale of the herring (Figure 8). The radii are more irregular and incomplete medially in the herring. In the alewife also they tend to be incomplete. Each radius (except the base line?) arises in two parts, one on either side of the middle line (Figure 14,c). Each half grows laterally and medially. They may fail to reach the middle line, as in the "anterior side" scales (Figure 13,e); they may unite regularly in the middle line, as in the "side" scales (Figure 15,b); they may alternate with each other and grow past the middle line without uniting, as for the majority of the radii of the "tail" scale in Figure 14,d; or they may alternate with each other, grow past the middle line, and each unite with the one immediately behind, giving a zig-zag condition of the radii along the middle of the scale.

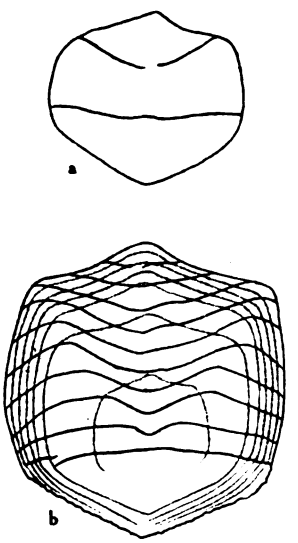


FIG. 15. *P. pseudoharengus*. (a) 74 mm. long, "side" scale × 10; (b) 236 mm. long, "side" scale × 5.

It has been sufficiently well shown that there is a definite relation between the direction of growth of the radii and circuli and the growth of the scale as a whole. Cause and effect cannot be readily separated. It is, however, suggested that the radii and circuli do not determine the shape of the scale. They belong to the outer layer of the scale, which grows by apposition of new material along the margin. The laminae of the inner part of the scale are composed of fibres, some of which run parallel to the margin and others perpendicular to the margin, whereas at some distance inside the condition is more irregular. They have accordingly a more definite relation to the shape of the scale than have the radii and circuli of the outer layer. It is most reasonable to suppose that the structure (inner wall of the scale pocket) which lays

Digitized by Google

down the fibres also determines the shape and extent of the scale, and that the cells which produce the outer layer are forced to conform in their growth as a whole to the shape and size determined by the inner wall of the scale pocket.

We have previously described another irregularity in growth, namely, a lack of correspondence between the upper and lower halves of the scale, which is so well exemplified by the "ventral" scale of the herring. Similar instances of less pronounced character are very frequently met with.

Paget and Savage (1916) have shown that the scales along the back of the herring differ from those on the sides and resemble the scales of most Teleosts, as for example the salmon. The radii are radial or approximately so, and the circuli are concentric to the focus.

We have found the change from the scales of the side to those of the back to take place in the herring in the following way: The slight anterior convexity of the circuli becomes more and more pronounced, until finally they are concentric to the focus and parallel to the margin of the scale. They do not extend into the posterior field. The radii in the posterior field become more distinct and gradually extend toward the focus. The radii in the anterior field are to a great extent deficient along the middle of the scale. They become still more restricted to the upper and lower margins, and their obliquity to the transverse axis increases, until finally they are almost longitudinal. Their anterior ends incline toward the middle line. Their position is lateral or to some extent posterior to the focus. They become connected with new radii, which develop near the anterior end. The final condition is one intermediate between that with a series of straight parallel lines running longitudinally and that with strictly radial lines. A similar, but less pronounced, change in the sculpture of the scales is to be seen on the ventral side of the body. The "ventral" scale (Figure 5) may be taken as an imperfect illustration of this change.

In the alewife is to be seen a similar condition of the scales along the dorsal and ventral sides of the body. The change from those of the side to those of the back is somewhat different from that described for the herring. Radii appear along the margin of the posterior field, extending farther and farther forwards, and inclining slightly toward the focus. In the anterior field we have seen that the anterior radii are bent predominantly forwards and the posterior, backwards, and that at times the radii connect with each other in a zig-zag fashion along the middle line. This condition becomes more and more pronounced

Digitized by Google

until finally there is a series of radii running anteroposteriorly through both fields, the middle of each radius being inclined toward the focus.

We have previously shown that the back is the last region to acquire scales. The ventral side of the tail is likewise relatively late in acquiring them. The gradation from the side to the dorsal and ventral surfaces is the order of the appearance of the scales. The time of origin of the scale may affect unequally the rates of growth of the parts and so determine the sculpture. There is also a progressive narrowing of the scale dorsally and ventrally. This of itself is sufficient to produce the change in sculpture, by altering the direction of growth of the cells that form the outer layer in the manner that has been described for the "side" and "tail" scales. That narrowing is sufficient for these changes is shown by the fact that in asymmetrical scales from the ventral surface the narrow, imperfectly developed side may have a condition the same as that of the scales of the back, whereas the other broad, well developed side may be quite similar to the scales of the side of the body.

There can be very little doubt that the simple factor of variation in the rates of growth of the parts of the scale is accountable for the differences seen in the shapes and patterns of scales from different regions. If these differ so much among themselves, it is not to be expected that there will necessarily be any close correspondence between the rate of growth of certain scales and that of the whole body or of the scale covered area, as shown by any of their dimensions.

Tautogolabrus adspersus. CUNNER.

A large series of individuals of this species from nine to thirty-three centimetres in length was obtained in St. Mary bay, Nova Scotia, in the early part of September, 1916. Scales were taken from each fish at a point on the side of the body at the tip of the pectoral fin when flexed against the body in a horizontal position. To these we have given the name "pectoral" scales. We are indebted to Dr. J. W. Mavor for suggesting this point as a convenient one from which to secure scales.

The dimension X in, where possible, ten scales from each fish has been measured and its average value determined. In the older fish the majority of the scales were regenerated so that in almost every case it was impossible to find as many as ten normal scales. The measurements of the body length were made to the nearest centimetre. Except for the extreme sizes, five fish from every other centimetre group have been considered. The results of the measurements are given in Table 11.

Digitized by Google

It will be seen that the value of the ratio $\frac{L}{X}$ at first decreases with age, and subsequently increases. This is shown graphically in Figure 16. The average value of X for each centimetre group has been plotted against the body length and a curve drawn to represent the normal change in X during growth. No very young fish are available to determine the character of the first part of the curve. The latter is strikingly similar to that for X in the "side" scales of the herring.

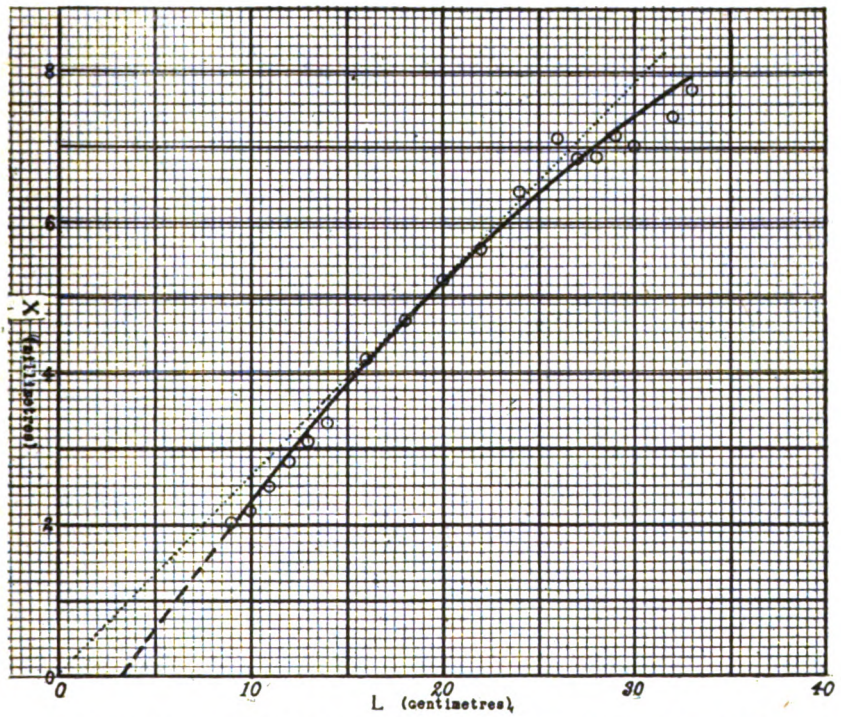


FIG. 16. *T. adspersus.* Relation of "pectoral" scale length (X) to body length (L).

Pseudopleuronectes americanus. FLOUNDER.

A fairly complete series of specimens of this species from the Bay of Fundy has been available. "Pectoral" scales were taken as for the preceding species, but from the blind side only. The fish were in most cases measured to the nearest centimetre, but in many of the smaller fish the measurements were made to millimetres.

Where possible scales from five individuals of each centimetre group have been measured. For the smaller sizes every centimetre group has been taken, but for the larger sizes fewer. The dimension measured has

Digitized by Google

been the total length (W). This has been chosen for convenience, owing to difficulty in seeing the focus of the scale. Measurements for ten scales for each fish have been made, and the average value of W determined. The results of the measurements are given in Table 12. It will readily be seen that in this species also the ratio of the body length to the dimension of the scale ($\frac{L}{W}$) decreases at first, but finally increases.

For each centimetre group the average value of $\frac{L}{W}$ has been found and from this a value of W for the group calculated. In Figure 17 these

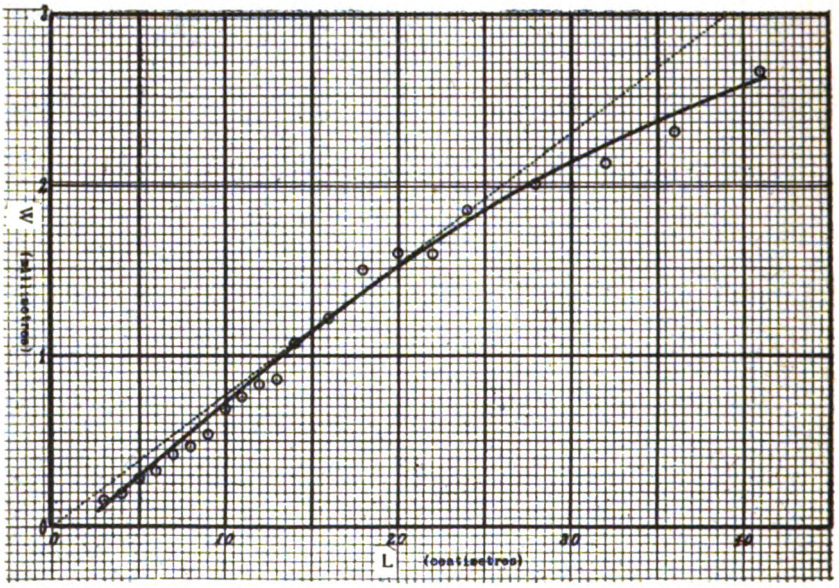


FIG. 17. *P. americanus.* Relation of "pectoral" scale length (W) to body length (L).

calculated values have been plotted against the body length and a curve drawn. Again we have a pronounced curve, which should have its origin at a body length of about two centimetres. The final decrease in the body-scale ratio is more marked than in the species previously studied. This may be related to the small size of the scales in this species. It might be expected that in fish with small scales, the scales would show an earlier and more pronounced decrease in rate of growth. At all stages, however, the scales of the flounder are proportionally smaller than those of the other species studied.

The difference in the dimension used in this species does not invalidate a comparison with the results for dimension X in the other species.

Digitized by Google

To judge from what was found for the alewife, the addition of Y to X, making W, would not change the character of the curve.

SUMMARY OF RESULTS.

The general statement that the growth of the scale corresponds with the growth of the fish, although substantially accurate, requires considerable modification.

In fishes belonging to such diverse groups as the *Clupeidae* (*Clupea harengus*), the *Labridae* (*Tautogolabrus adspersus*), and the *Pleuronectidae* (*Pseudopleuronectes americanus*) there is to be found a lack of correspondence in the rates of growth of the scales and of the body, as judged by their anteroposterior diameters (for the scale, particularly of the anterior field). The scale begins its growth later, grows relatively more rapidly than the body during the first half of life, and less rapidly than the body during the second half.

In the alewife (*Pomolobus pseudoharengus*) scales from different regions show differences in time of appearance and in rate of growth. The anterior and posterior fields of the scale do not appear at the same time, nor grow at the same rate. The posterior field appears first, grows very rapidly for a short period, and then at approximately the same rate as the entire fish. The anterior field does not grow uniformly, there being a lack of correspondence in the increase not only of the two chief diameters (transverse and longitudinal) but also of the several longitudinal diameters (median and lateral).

There is evidence of a lack of correspondence in growth between the two principal layers of the scale, and even between the parts of one layer.

It is suggested that simple variations in the rates of growth of the parts of the scale are responsible for the differences in shape and pattern of scales from different regions.

As concerns the use of the scales in determining the growth of the fish during the several years of its life, it will depend upon the degree of accuracy desired whether any notice be taken of the discrepancy between the growth of the scale and the growth of the fish. In any case the probable error arising from this source should be considered. It would not be difficult to determine the amount of correction necessary in a particular case. This would be of importance chiefly for the growth during the first year.

The best diameter for use in length calculations, if no correction is to be made, is the transverse in the *Clupeidae*. The posterior field would be preferable, but the indistinctness of the annual rings in that region renders it useless.

Digitized by Google

REFERENCES.

Agassiz, L.
1834. Recherches sur les poissons fossiles, 2e livr., t. 1. Neuchâtel.
Baudelot, M. E.
1873. Recherches sur la structure et le developpement des écailles des poissons osseux. Arch. Zool. Exper. et Gener., t. 2, pp. 87-244 and 429-480.
Cockerell, T. D. A.
1913. Observations on fish scales. Bull. Bur. Fish., v. 32, pp. 117-174.
Heusinger, C. F.
1823. System der Histologie. Erster Theil. Histographie. Eisenach.
Hoffbauer, C.
1899. Die Alterbestimmung des Karpfen an seiner Schuppe. Allg. Fisch. Zeit., Jg. 23, p. 341-343.
Klaatsch, H.
1890. Zur Morphologie der Fischschuppen und zur Geschichte der Hartsubstanzgewebe. Morph. Jahrb., Bd. 16, pp. 97-202.
Kuntzmann.
1824. Bemerkungen über die Schuppen der Fische. Verh. Gesell. Naturf. Freunde Berlin, Bd. 1, pp. 269-284.
Lea, E.
1910. On the methods used in the herring-investigations. Report on herring-investigations until January, 1910, by Johan Hjort. Publ. de Circon., no. 53, pp. 7-33.
1913. Further studies concerning the methods of calculating the growth of herrings. Publ. de Circon., no. 66, pp. 1-36.
Lee, R. M.
1912. An investigation into the methods of growth determination in fishes. Publ. de Circon., no. 63, pp. 1-35.
Leuwenhoeck, A.
1685. Opera omnia, t. 1, pp. 105-110. Lugduni Batavorum, 1722.
1696. Opera omnia, t. 3, pp. 191, 192. Lugduni Batavorum, 1722.
Mandl, L.
1839. Recherches sur la structure intime des écailles des poissons. Ann. Sc. Natur., ser. 2, t. 11, Zool., pp. 337-371.

Digitized by Google

Meek, A.
1916. The scales of the herring and their value as an aid to investigation. Rep. Dove Mar. Labor., for year ending June 30th, 1916, pp. 11-18.
Meyer, H. A.
1878. Beobachtungen über das Wachsthum des Herings im westlichen Theile der Ostsee. Jahr. Comm. Wiss. Unters. Deut. Meere, f. d. Jahre, 1874, 1875, 1876, pp. 229-251.
Milne, J. A.
1913. Pacific Salmon: an attempt to evolve something of their history from an examination of their scales. Proc. Zool. Soc. London, 1913, pp. 572-610.
Paget, G. W., and Savage, R. E.
1916. The growth-rings on herring scales. Proc. Roy. Soc. London, ser. B, v. 89, no. B615.
Taylor, H. F.
1916. The structure and growth of the scales of the squeteague and the pigfish as indicative of life history. Bull. Bur. Fish., v. 34, pp. 285-330.
Thomson, J. S.
1904. The periodic growth of scales in Gadidae as an index of age. Journ. Mar. Biol. Assoc., n.s., v. 7, no. 1, pp. 1-109.
Ussow, S. A.
1897. Die Entwickelung der Cycloid-Schuppe der Teleostier. Bull. Soc. Imp. Nat. Mosc., n.s., t. 11, pp. 339-354.
Vogt, C.
1842. Embryologie des Salmones. Hist. nat. des poissons d'eau douce de l'Europe centrale, par L. Agassiz, t. 1.
Williamson, W. C.
1851. Investigations into the structure and development of the scales and bones of fishes. Phil. Trans. Roy. Soc. London, v. 139, pt. 2, pp. 435-476.
Winge, O.
1915. On the value of the rings in the scales of the cod as a means of age determination, illustrated by marking experiments. Medd. Komm. f. Havunders., ser. Fiskeri, Bd. 4, nr. 8, pp. 1-21.

Digitized by Google

TABLE 1.

Clupea harengus. Relation of "branchial" scale length (V) to body length (L), both in millimetres. In 16 cases both right and left scales taken.

No...	1	2	3	4	5	6		7	8	9		10	11	12	13	14
L....	51	67	76	76	100	109		110	110	115		123	131	135	136	143
V....	(0.94)	2.36	2.58	2.62	3.95	3.8	3.6	3.8	4.1	4.8	4.65	4.6	4.75	4.6	4.85	4.55
L/V..	(54.2)	28.4	29.4	29.0	25.3	28.7	30.3	29.0	26.8	24.0	24.7	26.7	27.6	29.3	28.0	31.4
No...	15	16	17	18	19	20	21	22	23	24		25	26	27		28
L....	145	145	148	150	152	153	157	158	159	162		166	168	170		172
V....	4.75	5.4	4.7	4.7	6.0	5.1	6.0	6.5	5.8	5.75	5.65	6.25	6.25	6.4	6.15	6.25
L/V..	30.5	26.8	31.5	31.8	25.3	30.0	26.1	24.3	27.4	28.2	28.7	26.6	26.9	26.6	27.7	27.5
No...	29	30	31		32		33	34		35		36		37		38
L....	174	175	178		190		192	193		195		201		223		284
V....	6.3	6.3	6.3	6.5	6.4	6.2	7.1	6.85	6.25	6.85	6.8	6.4	6.4	8.5	8.1	10.7
L/V..	27.6	27.8	28.3	27.4	29.7	30.6	27.1	28.2	30.8	28.5	28.7	31.4	31.4	26.2	27.6	26.6
No...		39	40	41	42	43	44	45		46		47		48		49
L....		290	295	316	324	325	326	330		330		346		351		363
V....	10.6	10.5	11.4	11.0	11.5	12.1	13.5	13.6	13.9	13.5	14.0	12.5	12.7	14.7	13.7	14.2
L/V..	26.8	27.7	25.9	28.7	28.2	26.8	24.2	24.3	23.7	24.5	23.6	27.7	27.2	23.9	25.6	25.6
No...	50															
L....	365															
V....	14.2	14.6														
L/V..	25.7	25.0														

Digitized by Google

TABLE 2.

Clupea harengus. Relation of "ventral" scale length (W) to body length (L), both in millimetres. In 46 cases both right and left scales taken.

No....	1	2	3	4	5		6	7	8		9	10	11		12	13
L.....	48	49	51	61	67		76	80	87		95	99	100		106	109
W.....	0.44	0.56	0.97	1.62	1.9	2.1	2.5	3.0	3.55	3.65	3.7	3.6	4.15	4.25	5.1	4.6
L/W..	109	87.5	52.5	37.6	35.2	31.8	30.3	26.7	24.5	23.8	25.7	27.5	24.1	23.5	20.8	23.7
No....	14	15		16		17	18		19		20	21		22	23	
L.....	116	118		119		123	123		127		128	131		132	132	
W.....	5.45	5.2	5.1	5.2	5.4	6.6	6.0	6.35	5.6	5.7	5.9	6.0	5.6	6.0	6.5	6.25
L/W..	21.	22.7	23.3	22.8	22.0	18.6	20.5	19.4	22.7	22.3	21.7	21.8	23.3	22.0	20.3	21.2
No....	24		25		26		27		28	29		30		31	32	
L.....	136		139		141		143		145	145		145		147	148	
W.....	6.15	6.5	6.05	6.15	6.15	6.2	6.4	6.6	6.8	6.75	6.7	7.2	6.85	6.6	6.9	7.0
L/W..	22.2	20.9	22.9	22.6	22.9	22.7	22.3	21.7	21.3	21.5	21.7	20.2	21.2	22.2	21.4	21.2
No....	33	34		35		36	37	38	39	40		41		42		43
L.....	150	150		152		152	153	155	156	157		158		159		162
W.....	7.3	6.7	7.0	7.5	7.5	8.2	6.75	7.4	8.1	6.5	7.3	8.4	8.35	7.9	8.1	8.0
L/W..	20.6	22.4	21.4	20.2	20.2	18.5	22.7	20.9	19.3	24.1	21.5	18.8	18.9	20.2	19.7	20.2
No....	44		45		46	47		48		49		50	51	52	53	54
L.....	162		163		165	166		166		168		171	171	172	174	175
W.....	6.9	7.1	9.0	8.8	7.3	8.8	8.6	7.95	8.2	9.45	9.3	8.8	7.6	7.8	8.2	8.6
L/W..	23.5	22.8	18.1	18.5	22.7	18.9	19.3	20.9	20.2	17.8	18.1	19.4	22.5	22.1	22.2	20.3
No....	55		56	57		58		59	60	61		62	63		64	
L.....	176		177	177		178		182	187	190		192	193		195	
W.....	8.0	8.6	8.85	8.5	7.5	9.2	9.1	9.25	8.95	10.7	10.05	9.05	10.1	10.3	9.8	9.9
L/W..	22.0	20.5	20.1	20.8	23.7	19.4	19.6	19.7	20.7	17.8	18.9	21.2	19.1	18.7	19.9	19.7
No....	65		66		67		68		69	70	71		72		73	
L.....	201		212		222		223		276	278	284		285		290	
W.....	9.8	9.4	9.55	9.1	11.6	12.2	11.8	11.7	14.2	14.0	14.6	15.6	16.0	16.3	15.0	14.5
L/W..	20.5	21.4	22.2	23.2	19.1	18.2	18.9	19.1	19.4	19.9	19.5	18.2	17.8	17.5	19.3	20.0

Digitized by Google

TABLE 2—*Continued.*

No....	74	75	76	77		78		79		80		81		82		83
L.....	295	316	324	325		326		330		330		346		351		363
W.....	17.3	15.0	17.1	18.0	17.7	18.1	19.4	18.0	17.5	18.0	17.0	17.7	18.2	18.5	19.5	21.2
L/W..	17.1	21.1	19.0	18 1	18.4	18.0	16.8	18.3	18.9	18.3	19.4	19.5	19.0	18.9	18.0	17.2
No....	84															
L.....	365															
W.....	19.5	18.4														
L/W..	18.7	19.9														

TABLE 3.

Clupea harengus. Summary of relation of "ventral" scale length to body length, both in millimetres.

L....	48	49	51	61	67	76
L./W.	109	87.5	52.5	37.6	33.5	30.3
W....	0.44	0.56	0.97	1.62	2.0	2.5

L (range).....	80–99	100–128	131–148	150–174	175–195	201–223	276–295	316–365
L (midpoint).....	90	114	140	162	185	212	285	340
L/W (average)	25.6	22.0	21.8	20.5	20.1	20.3	18.74	18.67
W (calculated).....	3.52	5.18	6.40	7.90	9.20	10.4	15.2	18.2

Digitized by Google

TABLE 4.

Clupea harengus. Relation of "side" scale length (X) to body length (L), both in millimetres.

No.....	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
L.....	45	48	53	67	76	78	84	84	84	84	87	87	88	88	89	93
X.....	0	0	0.25	0.87	0.95	1.09	1.22	1.35	1.34	1.31	1.33	1.22	1.35	1.29	1.14	1.45
L/X...	∞	∞	212	77	80	76.5	68.8	62.2	62.5	64.0	65.3	71.2	65.2	68.2	63.0	64.0
No.....	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
L.....	93	93	96	99	99	99	100	100	101	101	102	104	106	107	107	108
X.....	1.43	1.45	1.46	1.56	1.74	1.63	1.62	1.84	1.56	1.61	1.67	1.71	1.94	1.98	2.02	1.99
L/X...	65.0	64.0	65.7	63.5	57.0	60.7	61.7	54.2	64.7	62.7	61.1	63.0	54.7	54.0	53.0	54.2
No.....	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
L.....	109	110	110	110	110	112	116	116	116	117	119	120	120	123	123	124
X.....	1.92	1.90	1.77	1.74	1.59	2.05	1.88	2.30	2.25	1.97	2.37	2.07	1.87	2.17	2.40	2.18
L/X...	56.8	57.8	62.0	63.2	69.2	54.5	61.7	50.4	51.5	59.3	50.2	58.0	64.3	56.7	51.2	56.8
No.....	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
L.....	125	125	125	126	126	127	130	130	131	132	135	136	137	139	139	140
X.....	2.11	2.13	2.29	2.43	2.42	2.42	2.51	2.10	2.26	2.44	2.81	2.42	2.50	2.73	2.55	2.72
L/X...	59.3	58.7	54.5	51.8	52.1	52.4	51.7	61.8	58.0	54.0	48.1	56.2	54.8	50.8	54.4	51.4
No.....	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
L.....	141	141	143	144	145	145	145	146	147	147	148	150	152	153	156	157
X.....	2.55	2.86	2.70	2.44	2.75	2.75	2.85	2.86	2.74	2.80	2.71	2.73	2.87	2.80	3.15	2.80
L/X...	55.2	49.3	52.9	58.9	52.7	52.7	50.8	51.1	53.5	52.5	54.5	54.8	53.0	54.5	49.4	56.0
No.....	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
L.....	158	159	161	161	162	162	163	163	165	165	165	166	166	166	168	169
X.....	3.20	2.96	2.92	2.98	3.00	3.35	3.10	3.05	3.22	3.03	3.09	3.46	3.28	3.35	3.12	3.09
L/X...	49.3	53.7	55.1	53.9	54.0	48.3	52.5	53.4	51.3	54.4	53.4	48.0	50.5	49.6	53.8	54.6
No.....	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112
L.....	171	172	175	176	178	178	178	178	179	181	181	182	186	186	186	188
X.....	3.47	3.30	3.40	3.44	3.49	3.20	3.38	3.52	3.27	3.53	3.77	3.80	3.48	3.89	4.52	3.75
L/X...	49.3	52.1	51.4	51.1	50.9	55.4	52.5	50.5	54.5	51.2	48.0	47.8	53.4	47.8	41.7	50.1

Digitized by Google

TABLE 4—*Continued.*

No.....	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128
L.....	190	190	192	192	193	194	195	196	197	198	200	200	201	202	204	204
X.....	3.87	3.65	3.92	3.78	3.56	3.73	3.68	3.90	3.78	3.86	4.23	3.95	3.70	3.96	3.67	3.90
L/X...	49.2	52.0	49.0	50.7	54.3	52.0	52.9	50.2	52.0	51.3	47.3	50.6	54.3	51.0	55.6	52.3
No.....	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144
L.....	206	206	209	210	210	210	211	213	214	214	216	217	218	219	220	220
X.....	4.42	4.02	3.97	4.45	4.39	4.09	4.19	4.42	4.08	4.13	4.24	4.26	4.00	4.46	4.03	4.61
L/X...	46.7	51.2	52.7	47.2	47.8	51.3	50.4	48.2	52.3	51.7	50.8	51.0	54.4	49.1	54.5	47.7
No.....	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
L.....	220	221	223	223	225	226	227	227	229	230	230	232	234	234	236	238
X.....	4.78	4.12	4.40	4.75	4.37	4.77	5.13	4.80	4.46	4.69	4.57	4.62	4.39	4.55	4.55	4.82
L/X...	46.0	53.6	50.7	47.0	51.5	47.4	44.2	47.2	51.3	49.0	50.3	50.2	53.3	51.4	51.8	49.5
No.....	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176
L.....	239	239	240	241	242	242	243	244	245	246	248	250	250	250	251	252
X.....	3.96	4.71	4.54	4.71	4.76	4.18	5.14	4.55	5.06	4.77	4.66	5.31	4.99	5.26	4.33	4.72
L/X...	60.3	50.7	52.8	51.1	50.7	57.7	47.2	53.5	48.5	51.5	53.3	47.2	50.0	47.6	56.6	53.3
No.....	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192
L.....	253	254	255	256	257	260	260	260	262	263	263	264	265	265	265	265
X.....	4.98	4.78	4.88	5.17	5.26	5.25	5.48	5.44	4.78	5.64	5.21	5.81	5.18	5.49	5.21	5.47
L/X...	50.8	53.0	52.2	49.5	48.9	49.5	47.5	47.7	54.7	46.7	50.4	45.4	51.1	48.2	50.7	48.5
No.....	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208
L.....	266	266	266	270	270	273	275	275	276	277	280	281	281	282	283	284
X.....	4.93	5.27	5.25	5.13	5.37	5.10	5.05	5.07	5.36	5.70	5.56	5.23	5.74	5.80	5.29	5.45
L/X...	53.8	50.5	50.7	52.6	50.2	53.5	54.4	54.3	51.5	48.6	50.3	53.7	48.9	48.5	53.5	52.2
No.....	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224
L.....	285	287	287	289	290	290	291	291	292	293	295	297	297	298	300	300
X.....	5.53	5.25	5.15	5.59	5.65	5.76	5.66	5.68	5.35	5.89	5.73	5.99	5.90	5.68	5.78	5.80
L/X...	51.5	54.7	56.7	51.7	51.3	50.4	51.3	51.2	54.5	49.7	51.4	49.5	50.3	52.4	51.8	51.7

Digitized by Google

TABLE 4—*Continued.*

No.....	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
L.....	301	301	301	304	305	307	310	310	310	311	312	312	312	312	315	316
X.....	5.85	5.64	5.61	5.70	5.26	5.87	5.91	5.99	5.82	6.34	5.71	5.89	5.58	5.24	6.01	6.10
L/X...	51.4	53.3	53.7	53.3	58.0	52.2	52.4	51.7	53.3	49.0	54.4	52.9	55.8	59.4	52.4	51.7
No.....	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256
L.....	316	317	317	318	320	321	323	323	325	326	327	328	330	330	330	330
X.....	5.89	5.94	5.79	6.01	6.55	6.49	5.76	5.85	6.10	6.40	6.80	6.47	6.38	6.02	6.10	6.35
L/X...	53.5	53.3	54.7	52.9	48.8	49.4	56.1	55.2	53.3	50.8	48.0	50.7	52.1	54.8	54.1	52.0
No.....	257	258	259	260	261	262	263	264	265	266	267					
L.....	331	333	339	340	340	345	346	350	351	363	364					
X.....	6.29	6.16	6.60	6.20	6.12	7.14	6.80	6.40	6.90	7.50	6.70					
L/X...	52.5	54.1	51.3	54.8	55.5	48.3	50.8	54.7	50.8	48.5	54.3					

TABLE 5.

Clupea harengus. Summary of relation of "side" scale length to body length, both in millimetres.

A. From data given in Table 4.

L.....	53	67	80	90	100	110	120	130	140	150
L/X.....	212	77	69	65.7	61.43	58.02	56.01	55.43	53.20	53.01
X.....	0.25	0.87	1.16	1.37	1.63	1.90	2.14	2.34	2.63	2.83
L.....	160	170	180	190	200	210	220	230	240	250
L/X.....	52.56	51.70	51.33	50.02	51.75	49.95	50.48	49.58	52.52	51.18
X.....	3.05	3.30	3.51	3.80	3.87	4.20	4.36	4.64	4.57	4.88

L.....	260	270	280	290	300	310	320	330	340	350	360
L/X.....	49.25	50.99	51.59	52.30	51.88	53.91	52.80	52.24	53.86	51.15	51.90
X.....	5.27	5.30	5.43	5.53	5.77	5.74	6.05	6.33	6.31	6.84	6.93

B. From additional data.

L.....	110	120	130	140	150	160	170	180	190	200
L/X.....	59.03	58.00	56.10	54.60	52.63	53.40	52.30	52.31	51.70	52.90
X.....	1.86	2.07	2.32	2.57	2.85	2.99	3.25	3.44	3.67	3.78

Digitized by Google

TABLE 6.

Clupea harengus. Relation of "side" scale width (V) to body length (L), both in millimetres.

Number of individuals	1	1	1	1	2	2	3	4	9	14	12	13
Range in L	..	...	....	....	....	....	99–100	106–110	115–124	125–132	135–143	145–153
L (standard)	45	48	53	67	76	87	100	110	120	130	140	150
L/V (average)	∞	120	75	47	44	40	38.8	37.4	37.7	38.3	36.8	37.3
V (calc'l't'd)	0	0.4	0.71	1.43	1.74	2.16	2.57	2.93	3.18	3.40	3.80	4.02

Number of individuals	10	13	10	6	7	6	6	6
Range in L	155–163	165–174	175–182	186–193	195–223	255–285	290–326	330–363
L (standard)	160	170	180	190	210	270	310	345
L/V (average)	36.1	35.6	36.1	37.9	36.4	34.2	33.4	33.9
V (calculated)	4.44	4.78	4.98	5.01	5.77	7.90	9.30	10.20

TABLE 7.

Clupea harengus. Variation in length as calculated at different ages. For further explanation see text. Underlined lengths are actual.

Winter period when calculated	Calculated length in millimetres for 1st	2nd	3rd	4th	5th	6th	7th	Winter period
1st	80							
2nd	60	150						
3rd	57	143	200					
4th	57	143	200	230				
5th	57	144	201	232	260			
6th	57.5	145	202	233	262	280		
7th	57.5	145.5	203	234	263.5	282	300	

Digitized by Google

TABLE 8.

Pomolobus pseudoharengus. Relation of "anterior side" scales (dimensions V, W, X, and Y) to body length (L), measurements in millimetres.

No.	L	V	L/V	W	L/W	X	L/X	Y	L/Y
1	28	0.2	140	0.17	165	0	∞	0.17	165
2	29	0.45	64.5	0.30	97	0.05	580	0.25	116
3	30	0.79	38	0.52	58	0.15	200	0.37	82
4	32	0.82	38.8	0.54	59	0.20	160	0.34	94
5	45	1.28	35	0.96	47	0.43	104	0.53	86
6	52	1.58	33	1.4	46	0.61	84	0.79	100
7	64	2.00	32	1.6	40	0.89	72.5	0.71	89
8	74	2.55	29	1.9	39	1.09	68	0.81	90
9	236	8.60	27.4	7.4	31.8	4.50	52.3	2.90	81

TABLE 9.

Pomolobus pseudoharengus. Relation of "side" scale (dimensions V, W, X, and Y) to body length (L), measurements in millimetres.

No.	L	V	L/V	W	L/W	X	L/X	Y	L/Y
1	29.5	0.18	164	0.18	164	0	∞	0.18	164
		0.44	67	0.31	95	0.027	1100	0.283	104
		0.51	58	0.345	86	0.055	535	0.29	102
2	30	0.62	48.5	0.5	60	0.13	230	0.37	81
3	32	0.7	46	0.5	64	0.1	320	0.4	80
4	37	0.9	41	0.65	57	0.25	148	0.4	92.5
5	45	1.2	37.5	1.05	43	0.5	90	0.55	82
6	53	1.7	31	1.33	40	0.73	72.5	0.6	88
7	60	2.0	30	1.65	36.5	0.9	67	0.75	80
8	78	2.6	30	2.1	37	1.275	61	0.825	94
9	236	7.6	31	7.7	30.6	5.0	47	2.7	87

Digitized by Google

TABLE 10.

Pomolobus pseudoharengus. Relation of "tail" scales (dimensions V, W, X, and Y) to body length (L), measurements in millimetres.

No.	L	V	L/V	W	L/W	X	L/X	Y	L/Y
1	28	0.355	79	0.32	87	0	∞	0.32	87
2	29	0.69	42	0.57	51	0.21	138	0.36	80.5
3	32	0.82	39	0.655	48.8	0.245	130	0.41	78
4	38	0.8	47.5	0.69	55	0.255	149	0.435	87.5
5	43	1.065	40.5	0.96	44.8	0.444	97	0.52	83
6	45	1.18	38.1	1.09	41.3	0.565	79.5	0.525	86
7	54	1.5	36	1.42	38	0.74	73	0.68	79
8	61	1.6	38	1.54	39.5	0.78	78	0.76	80
9	65	1.85	35	1.75	37	0.95	68.5	0.8	81
10	74	2.41	30.6	2.24	33	1.36	54	0.88	84
11	236	6.4	36.8	7.1	33.2	4.7	50	2.4	98

TABLE 11.

Tautogolabrus adspersus. Relation of "pectoral" scale length (X) to body length (L), both in millimetres.

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
L	90	90	90	100	100	100	100	100	100	110	110	110	110	110	120	120
X	1.86	2.26	1.96	1.99	2.14	2.04	2.18	2.29	2.33	2.53	2.46	2.55	2.29	2.73	2.60	3.17
L/X	48.3	39.8	45.8	50.1	46.7	49	45.7	43.6	42.7	43.3	44.6	43.1	47.8	40.2	46.1	37.8
No.	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
L	120	120	120	130	130	130	130	130	140	140	140	140	140	160	160	160
X	2.85	2.88	2.74	2.93	2.85	3.35	3.25	3.15	3.26	3.06	3.35	3.42	3.60	4.42	4.17	3.84
L/X	42.1	41.7	43.7	44.3	45.7	38.8	39.9	41.2	42.8	45.7	41.7	40.9	38.8	36.2	38.3	41.7
No.	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
L	160	160	180	180	180	180	180	200	200	200	200	200	220	220	220	220
X	4.07	4.50	4.54	4.40	4.86	4.56	4.43	5.29	5.29	5.01	5.36	5.27	4.87	5.97	5.87	5.92
L/X	39.3	35.5	39.7	40.8	37	39.5	40.6	37.8	37.8	39.8	37.3	37.9	45.2	36.8	37.4	37.1
No.	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
L	220	220	220	240	240	240	240	240	240	260	260	260	260	260	260	270
X	5.82	5.43	5.68	6.90	6.00	6.33	6.90	6.10	6.25	6.80	7.40	6.41	7.10	7.36	7.62	7.00
L/X	37.8	40.5	38.7	34.8	40	37.8	34.8	39.3	38.4	38.2	35.2	40.4	36.6	35.3	34.1	38.5
No.	65	66	67	68	69	70	71	72	73	74	75	76	77	78		
L	270	270	280	280	280	280	290	290	300	300	320	320	330	330		
X	6.70	6.80	7.00	5.90	7.80	6.70	7.05	7.23	6.85	7.20	7.37	7.40	7.50	8.03		
L/X	40.2	39.6	40	47.3	35.8	41.7	41.2	40.2	43.8	41.7	43.4	43.2	44	41.2		

Digitized by Google

TABLE 12.

Pseudopleuronectes americanus. Relation of "pectoral" scale length (W) to body length (L) both in millimetres.

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
L.	30	32	36	39	43	44.5	47	54	56	58	60	63	63	68	70	72
W.	0.15	0.18	0.17	0.19	0.21	0.22	0.27	0.29	0.27	0.33	0.34	0.33	0.36	0.41	0.44	0.45
L/W.	200	178	212	206	205	202	174	186	207	176	177	191	175	166	159	160
No.	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
L.	73	74	76	76	77	78	82	90	90	91	100	100	107	110	110	110
W.	0.38	0.45	0.47	0.46	0.47	0.48	0.43	0.52	0.56	0.53	0.65	0.76	0.63	0.68	0.78	0.74
L/W.	192	165	162	165	164	163	191	173	161	172	153	132	169	161	141	149
No.	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
L.	110	120	120	122	123	125	128	130	130	140	140	140	140	140	160	160
W.	0.8	0.88	0.81	0.94	0.76	0.79	0.75	1.04	0.88	1.03	1.13	1.07	1.10	1.09	1.40	1.24
L/W.	137	136	148	130	162	158	171	125	147	136	124	131	127	128	114	129
No.	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
L.	160	160	160	180	180	180	180	180	200	200	200	200	200	220	220	220
W.	1.07	1.21	1.20	1.48	1.54	1.43	1.60	1.53	1.61	1.54	1.53	1.54	1.85	1.75	1.35	1.73
L/W.	149	132	133	122	117	126	112	118	124	130	130	130	108	125	163	127
No.	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
L.	220	220	240	240	240	240	240	280	280	280	280	280	320	320	320	320
W.	1.45	1.72	1.70	1.82	1.98	1.87	1.93	2.18	2.05	2.25	1.93	1.65	2.37	2.14	1.91	2.09
L/W.	151	128	141	132	121	128	124	128	136	124	145	169	135	149	167	153
No.							81	82	83	84	85	86	87	88	89	90
L.							320	360	360	360	360	360	410	410	410	410
W.							2.16	2.24	2.17	2.57	2.42	2.20	2.81	2.42	2.74	2.71
L/W.							148	161	166	140	148	164	136	170	150	151

Digitized by Google

Digitized by Google

INTELLECTUAL CONSEQUENCES OF THE WAR.

FRANKLIN H. GIDDINGS, Ph.D., LL.D.

Great wars do not leave the human mind as they find it.

They may redraw the political map of continents, or not; they may open important routes of trade, or close them; they may sweep the surface of society or trouble its depths; they may create imperative problems for statesmen or only interesting ones for philosophers; but in the one case or the other they recombine the primordial elements of mind itself, and recondition its functioning.

So I would state the thesis that I hope to clarify and shall try to establish in what I am privileged to say this evening on the Intellectual Consequences of the fateful war now closing.

It is not so revolutionary a thesis as perhaps it sounds. We are accustomed to think of human nature as less variable than institutions are, and more certain to repeat itself than history is. I do not question this view of the matter. I only point out that human nature inheres in the primordial elements of mind and not in their combinations, which are by no means unchanging, and not in the functioning of the synthetic product; and it is with these latter things that I am concerned. I shall contend that war reconditions our instincts (to use a phrase from psychology which presently I will explain) and emancipates our imaginations, and that the war which a bandit empire started in 1914 has reconditioned and emancipated on a scale that no antecedent crisis in human affairs had prepared the scientific intellect to apprehend or to measure.

The first reaction of the western peoples to the German assault was less a sense of physical apprehension than a profound moral consternation.

Belgium and France indeed knew that for them the struggle meant life or death, and it is to their imperishable glory that they instantly chose to die, if that should be the decree of fate, rather than fail to deliver any blow in their power to strike against the collective assassin. The British Empire did not for the moment believe that Germany could greatly impair Britain's stupendous strength. The United States did not take seriously the warnings of its better informed publicists that Germany intended world conquest and, if successful in Europe, would attack the

Digitized by Google

Western Hemisphere. Italy and Greece were unable to react until they freed themselves from the toils of German intrigue.

It is true also and we should not forget that in both Great Britain and America there was on one point profound apprehension which, although not physical fear was akin to it. Great Britain and Canada, Australia and the South African Colonies, and the United States, all relied at that time upon volunteer forces for military defence. It was immediately seen that a prolonged and murderous war would appallingly deplete the physically and mentally best stocks of the western nations. Everywhere college and university men were first to see the significance of the conflict and first to respond in enlistment. Had the peril not been apprehended and vigorously met by organized pressure upon laggards and slackers, the military consequence might have been disastrous, and even if that had not happened the remoter injury to the democratic populations, as the inheritors and guardians of civilization, would have been incalculable. It will stand among the most creditable decisions of Canada and of the United States that they handled the problem at once intelligently and fearlessly by resorting to conscription and the selective draft.

Moral consternation in the autumn of 1914 was universal. The world had settled into a comfortable belief that Europe and America had become too intelligent and too prudent to engage again in a general war. Visions of universal and enduring peace, long decried as utopian, had begun to influence the matter-of-fact thinking of practical men. International conciliation and the future of the Hague Tribunal had engaged the earnest effort of superior minds. Financiers had been confident that the pressure which they had brought to bear upon legislative bodies in democracies they could successfully exert also through business channels upon absolutist governments. Militarism had been looked upon as an obsession, challenging and dangerous, but not uncontrollable by the augmenting power of wealth and enlightenment. Even international socialism had been kindly regarded as an influence that might work strongly for peace.

Naturally enough, therefore, when the storm broke men began asking themselves what had been wrong with their inventory of facts or with the conclusions drawn.

Progress itself was questioned. The latter half of the nineteenth century had witnessed three amazing changes in the state of mankind. The discoveries and inventions of the last half of the eighteenth century and the first half of the nineteenth had made possible a fabulous pro-

Digitized by Google

duction of wealth and a free circulation of material goods throughout the world. An enormous increase of food supplies had been followed by a lowering of death rates and a multiplication of human beings which that sober minded British statistician, Longstaff, declared to be a phenomenon unique in history. So swift and bewildering were these changes in economic status that it became a fashion among political economists to talk about the theories of Malthus as disproven and discredited. The third change was intellectual. Our conception of the universe was reconstructed. Herbert Spencer's account of cosmic evolution and Darwin's patiently elaborated conclusions upon the origin of species and the descent of man, hotly opposed at first, made their way to acceptance by conviction among the intellectual elite, and to acceptance as facts of course among the well informed.

At the opening of the twentieth century a strong movement was discernible to distribute the new material and intellectual gains among the masses of human beings and to re-fashion the fabric of human society. It was held by men not to be described as mere enthusiasts or builders of utopias, that poverty could be abolished; that ignorance could be dispelled; that crime and vice could be eradicated; and that war, the supreme evil, could be prevented forever. By his mastery of scientific methods and his accumulation of scientific knowledge man had attained control of physical processes. He had demonstrated his ability to handle his more pressing economic problems. Why, then, should he doubt his power to control conduct, to dominate moral situations, and to make a millenium of social justice? The vision dazzled. It was the picture of a world shaped by the blind forces of physical energy but brought under the mastery of intellect; of a human race that had struggled up from savagery through ages of terror, taking itself in hand at last, and ruling itself by reason.

What was wrong with it? Was it only exaggerated—out of drawing and too highly coloured, or was it false altogether? Some at least of its component elements were facts. Scientific method and its undeniable achievement, the great inventions, the increase of wealth and of population, these at least were indubitable realities. But was moral amelioration also a fact? That was the vital question. Had theory fooled us? Was evolution perhaps, after all, only a redistribution of matter and motion? Was moral progress as inevitable as we had perhaps too hastily assumed? The dream of peace at any rate had dissolved, and war, desolating the earth again, was the present fact, a more appalling fact than mankind ever before had looked upon.

Digitized by Google

Explanations were various. Most of them were random guesses. The most radical one questioned the adequacy of reason to control behaviour or to regulate affairs. Civilization, it was said despairingly, had turned out to be only a manner, or mode. Man himself, perhaps we had to admit, had not greatly changed. Savage in his instincts as of old, with passions made turbulent by modern excitements and opportunities, he remained as ever ready to fling aside his trinkets and adornments and to grasp his weapons of butchery.

It may be doubted if a more sobering thought has ever been entertained by the human mind. It is no wonder that book shops enjoyed a lively trade, as they did, in pamphlets on herd instinct, and writings which sought to prove that patriotism itself is only a phase of mob mindedness; no wonder that men of little faith gave themselves over to the pessimistic conclusion that wars must repeat themselves to the end of time. Only the pacifist held his untroubled way, proffering his outheld pinch of the salt of non-resistance for the capture of the dove of peace.

It is not well for man to think of himself more highly than he ought to think, but the wounding of pride is salutary only if clearer vision and a truer estimate of self awaken new resolve; and the moral experience of 1914 was depressing. Happily it was not destined to paralyze. Swiftly and terribly the war itself gave answer to all questionings and resolved all doubts. And the answer was startling. The German Empire proclaimed itself savage and proved the proposition. Belgium, France and Great Britain made few professions, but in the face of galling provocation and fighting for self-preservation, they did not and could not wage war in the German fashion. One half of the white population of Europe, it appeared, had made material progress only; the other half, it appeared, had made substantial moral gains.

It is needless to recount the tale of German crimes, but it is not unprofitable to call to mind their variety of offense. Brazenly the Imperial German Empire foreswore itself. Covenants and treaties it tore to tatters. The rights of neutrals and non-combatants it trampled under heel. The weak and defenseless it tortured. Women and children it murdered. And these infamies it perpetrated, not in madness of combat, but by premeditation and command. Its frightfulness was ingenious and calculating. It revived and improved upon the atrocities of the Assyrian. It gloated over the "Lusitania". It crucified living men. It nailed a living kitten to the wall, knowing that Englishmen would pull the nails and so be blown to atoms. With malice prepense it fired upon ambulance trains and hospitals. It destroyed Louvain and Rheims in

Digitized by Google

senseless wantonness. It defiled beauty as swine do. In these crimes of their Government the German people participated and exulted. And when Government and people had been defeated in battle they grovelled before their conquerors and abjectly asked to be fed.

Such are the outstanding evidences, irreducible and compelling, that the Teutonic peoples of central Europe dominated by the Prussian of whom Goethe said "He is cruel by nature, civilization will make him ferocious", and of whom Heinrich Heine said "Nature has made the Prussians stupid, science has made them wicked", had not made substantial moral progress down to the year of desolation, 1914.

Briefer than the summary of German crime may be our word upon the contrasting war record of the Entente Allies. They did not defile; they did not wantonly destroy; they did not murder; they kept their word. If any among them had sworn to his hurt he abided by his oath. Belgium kept faith with France and France with Russia. England kept faith with Belgium and with France. Canada, Australia and South Africa kept faith with England. Italy, impoverished and practically unarmed, in strict letter of the law, and risking annihilation, withdrew from the Triple Alliance and, as soon as half prepared, threw herself into the conflict against the Teutonic powers. These facts alone are adequate proof that the Entente Allies were obedient to moral law and mindful of its highest expression in the conventions of international law, yet there is an important thing to add. One and all, the peoples of these nations underwent a profound spiritual experience, and it was more than a phenomenon of feeling. It was intellectually clear. They perceived the true nature and the meaning of the strife. They knew that they were fighting for more than their own hearth stones. They knew that human liberty throughout the world was at stake and that civilization itself was imperilled. So realizing, they offered every joy of life to hold by duty and by self respect. In this decision it was the privilege of the United States to share.

So the case was made up, and so it stands for generations to contemplate. The reality of moral progress cannot again be called in question. A part of the human race has achieved it. The fact is proven: it takes its place in the category of things demonstrated. That which we dared to believe, we know. The mind is convinced, and this certitude is the immediate, and for the moment the obvious intellectual consequence of the war.

Have we, however, assurance of further gain, or even that we shall keep the gains already made? In a supreme crisis the nations have

Digitized by Google

behaved well, but is the human mind itself unalterably committed to choose henceforth the nobler part? This is the deeper question, to which we now seek answer.

The world has been loath to believe that all Germans like Prussians, are cruel and bestial by nature. It has preferred to believe that the populations of the Rhine lands and of the south were debased by premeditated effort directed to that end. The Hohenzollern Dynasty had controlled its subjects as no other imperial power had controlled in modern times. It had imposed militarism upon them as a habit of thought and of action. It had taught them to regard themselves as a superior and indomitable race, and to bear themselves arrogantly. It had inculcated hatred and contempt of potential foes. It had told them that kultur was at once a superior knowledge, a superior morality and a superior social organization, and warned them to stand ready to impose it by the sword upon all mankind. It had held before them the vision and the expectation of a Prussianized middle Europe, swiftly extending its authority throughout the world. This teaching, it is widely held, accomplished its purpose, and sufficiently explains German conduct without presuming that Germans are by nature more reprehensible than Englishmen, or Frenchmen, or Americans.

The explanation rests upon an assumption often made unconsciously no doubt, but possibly admitting of scientific justification. It is the assumption that education of the intellect and that broader education which we call "habit" are adequate to control the inherited nature of man. To examine this assumption it is necessary for a moment to turn to certain interesting contentions of psychology.

The automatic reflexes of the nervous systems of animals and of men and the elementary instincts, which are more complex reactions of specific nervous mechanisms, may be called forth, it seems, by exceedingly varied stimulations. A piece of meat in a dog's mouth causes a flow of saliva. A Russian psychologist, Pawlow, tried the experiment of tinkling a bell when the dog was fed. In course of time the tinkling of the bell without the presence of the meat called forth the reflex and produced the salivation. Hundreds of similar experiments suggested by Pawlow's have demonstrated that simple reflexes and elementary instincts can be reconditioned, practically at will. The word means simply that reflexes and instincts can be subjected to conditions that are new to individual experience. They can be detached from old stimuli and associated strongly with new ones, and this possibility, the psychologists tell us, is the physiological basis of our power to learn.

Digitized by Google

It follows that our instinctive drives and mechanisms may be linked up with things of evil or with things of good report. They may be made to destroy or to build. Hunger, anger and fear may be incited to steal and inflamed to slay, or they may be prompted to feed the destitute and to defend the weak; trained to provide against want, and disciplined to safeguard the commonwealth. German university faculties may be taught to bluster at the rattling of a kaiser's sword as the dog to slobber at the ringing of a bell; and American plutocrats to take orders from chaffeurs turned captains, in defense of immaterial values.

These are reassuring facts. They permit us to accept the Mendelian laws of heredity and yet to retain our faith in education. Nevertheless, they carry explanations of war and peace but a little way: they do not interpret history. Society is more than gregariousness, and politics are more than explosions of herd instinct.

The calculus of utilities, which is the theoretical element of classical political economy, is not more adequate. The number of human beings who reason, in the logician's sense of the word, is small. An exaggerated estimate of the possibilities of appeal to a calculated interest has always been the practical weakness of that British liberalism which harks back to Bentham and Mill.

The masses of humankind are more than instinctive and less than logical. Between instinct and logic is a vast realm of mental facts, not yet fully explored. Among these half apprehended things of the intermediate range must be sought the conscious drives that dominate human behaviour in its pluralistic or collective phase: the empirical interests that generate collective beliefs, that shape mores or customs, that organize working relations, that dictate policy. To discover these dynamic but consciously entertained interests, or activities of the mind, is an essential part of the scientific task of the psychologist of society.

It is my own belief, which I advance in all deference to students who may have other explanations to offer, that imagination plays a chief part in distinctively human affairs, by which I mean, collective conduct above the level of instinctive behaviour. Nearly everybody has imagination, more or less. For a majority of persons, it is probable, thinking consists in putting concrete images together into a pictorial whole rather than in trying out coherences among abstract notions, or concepts. Of the power of pictures to fascinate we have compelling proof in the unexampled popularity of the cinematographic screen. Whether an inexhaustible supply of realistic pictures exhibited to the physical eye stimulates imagination or paralyzes it, is a question that has not been

Digitized by Google

answered. There can be little doubt, however, that it instructs imagination, and makes its operations increasingly accurate.

Now imagination, like instinct, is conditioned. It is awakened by innumerable stimuli, and its attachments are inconstant. Indeed, it appears to be almost inordinately fond of variety. It is therefore teachable, it can be educated, and the practical importance of educating it lies in the fact that it is not only a reaction, an end attained, but also, like every other mental fact, in its turn a stimulus. Its power to engender and to confirm belief is almost uncanny, and through belief it controls action. The witchcraft panics of the fifteenth, sixteenth and seventeenth centuries were in the main a creation of distraught imaginations, fed by an ignorant and superstitious pulpit. In the light of subsequent events it is not insignificant that they attained their widest extent and utmost ferocity in Germany. For the outbreak in Massachusetts the Reverend Cotton Mather boasted his individual responsibility.

We have fallen into a habit of thinking about imagination, or should I say of imagining imagination, in much too fragmentary terms. We picture it as occupying itself either childishly, with things fanciful or visionary, or else in serious artistic creation, as in fiction, or music, or sculpture, or architecture. The truth, of course, is that imagination busies itself literally with everything. Nothing is too practical or too commonplace, or too common-sensible for it to play with. Discoveries and inventions, as Professor Tyndall reminded us in his famous essay on Scientific Uses of the Imagination, are creations of imaginative genius. Copernicus and Galileo were not less gifted than Dante and Michael Angelo with divine power to see. Stephenson, Fulton, and Wilbur Wright were wizards of imagination, as are Marconi and Pupin.

Yet, while imagination readily attaches itself to anything whatsoever, small or great, commonplace or wonderful, it can become a creature of habit and easily get into a rut, and this is a part of the reason why we have so many curious "types of character" that are not fully explained by heredity. For example, consider two types upon which our modern slang-making propensity has fastened the names, "the knocker" and "the easy-mark". The "knocker" is the inveterate fault finder. From the moment of awaking in the morning until he falls asleep at night, his imagination is busy with the sins and blunders of his fellow men. Nothing that is wrong or mistaken escapes him. Nothing that is excellent or commendable has reality for him. He has lost the power to imagine good intentions, good judgment, good conduct. The "easy-mark", by contrast, can think no ill, that is to say, he can imagine no ill, of his neighbour,

Digitized by Google

or of the stranger within his gates. He sees the fakir as a discoverer, and the promoter as a financier. They victimized him yesterday, they will "do" him to-morrow, but his faith will not be shaken. He doesn't believe that the Kaiser meant harm, or that Leon Trotsky could tell a lie. He would have us forgive infamy and buy Bolshevikist bonds. Familiar types, not unrelated to these two, are Benjamin Franklin's "Poor Richard" to whom the smallest waste or thriftlessness is sin, and who can see nothing in beauty but its expensiveness, and the "artistic temperament", which is powerless to forecast, and ever unready to pay its bills. Yet other contrasts (and after these it is unnecessary to mention more) are the locally-minded man, for whom the world beyond his village does not exist, and the internationalist, who would be a man without a country if his unfeeling government would let him.

It is reasonable to suppose that these and a hundred other character types that we smile at and good naturedly tolerate, are products, in part, of a one-sided experience calling forth and developing native idiosyncracies. They need the education which comes when crisis tears imagination from its old attachments and compels it to consort with new interests. Exactly such education, I venture now to suggest, has been the prime maker and fashioner of that fabric of attitudes, interests, activities and relationships which we call civilization. Since the day when the first thinker discovered that he could make a sharper edge by pressing flint than by chipping it, this education has been lifting man to new achievements and rewarding him with a more abundant happiness.

A thousand things may recondition the imagination, but among them all none has been so inexorable and none so effective as war.

It was ever-recurring war that compelled men to fortify advantageous places and brought together there nondescript fugitives and fragments of broken clans; whereby it became possible to imagine, and by imagination to create, communities of town dwellers, superseding tribal organizations. Again, it was recurring war that compelled petty states to confederate, so making it possible to imagine, and imagining to create, territorial nations. Wars of conquest, in their turn, enticed imagination from nationalistic entities and set it upon the ambitious task of creating imperial systems. These overspread the world, and in arrogance of power proclaimed themselves established as the everlasting hills.

But war can work within as well as without. Wars of revolt began. As a consuming flame they grew into wars of revolution. Imagination forgot its centuries long attachment to thrones to associate itself with

Digitized by Google

popular majorities. It created democracies. They were small and feeble. Their life was precarious, but they multiplied and they grew. Then, in the fullness of time, a civil war in the United States detached imagination from the provincial commonwealth, which it had pictured as sovereign and self-sufficient, and fixed it unalterably upon a larger political possibility. A democratic nation was created, adequate to hold its own in the struggle for existence, and competent to take its part, when the day should come, in defending the liberties of mankind.

Beyond all wars of the past the war of 1914 reconditioned and rekindled imagination. Beyond all other wars it broke up traditional attachments and antipathies, and this not for exceptional individuals only, but rather for millions of common men who now, for the first time since common men became a political power, pictured forth the round world of continents and seas, of races and religions, of parliaments and camps, as scene and forces of political strife. It made the map concrete. It made history live, as story book, or play. Nations that had been school book names became armies with banners; or producers of wheat, or of coal; or areas of empire, or of democracy. Who that saw Fifth Avenue on the day that Marshal Joffre rode through it, or again, as the Avenue of the Allies, can forget that glory of colour, that surging life, that comingling of flags and of peoples, that look in the eyes of men! Forever emancipated from localism and from provincial pride, imagination took the earth and its inhabitants for its own, and wove the continuity of yesterday with to-morrow.

Next after demonstration of the fact of moral progress the birth of a world imagination was the momentous intellectual consequence of the war.

What the world imagination may achieve for human happiness in coming years let us not at this time too rashly predict. Perhaps it will create a "parliament of man", a practical "federation of the world". We do not know. That it will reaffirm international law and its obligations, that it will protect the weak and establish justice in economic as in political relations, we confidently hope. What it has already done is another matter, and reasonably clear. It has revised and reconstructed our scale of values. To use Nietzsche's phrase, it has revalued all values to a degree that Nietzsche never dreamed of and in directions that he did not contemplate. It has made substitutions and altered proportions. The list of changes is too long to recount, but among them are three, important enough to be picked out for particular consideration.

Digitized by Google

The first one is a case of material or economic value. The world imagination, playing upon the dreadful experience of war, has reconstructed our notions of economic cost and gain.

Before 1914 we were living, as far as economic matters are concerned, in a fool's paradise. Extravagance was universal. We were wasteful beyond belief. We wasted money, we wasted energy, we wasted time; but most unpardonable of all, we wasted those natural resources of the earth which are of limited supply and the exhaustion of which imperils the future of the race.

Forests were destroyed. Coal and iron were consumed in smoke and rust more than in units of work. The fertility of agricultural lands was exhausted. For all this squandering a vicious teaching was in part responsible. The older economists had told us of the law of diminishing return and warned us of its consequences, but a newer school of writers had arisen who assured us that scientific discovery had changed all that. Inventions, they said, would indefinitely increase man's power to produce food and all material satisfactions, and so they argued down the earlier wisdom. The fallacy of their reasoning, as we see it now, was discreditable. It was neglect of one of the simplest but most stubborn facts that the physicist could have told them of. The more ingenious and precise our technical processes become the more strictly dependent are they upon the employment of specific materials for which no satisfactory substitutes are found. What would be the material state of mankind to-day without copper, or sulphur, or glycerine, or even of that exceedingly rare metal—platinum? There is nitrogen enough in the air to restore the fertility of exhausted lands, but how to capture and fix it without using up the known supply of other vitally necessary things is a question not answered. The chemist could give us heat and light and power, renewal of youth and length of days if he could get the radium that he knows how to use; but where is the radium?

Disguise it as we will the law of diminishing return is a fact, and neither the gospel of non-resistance nor the League to Enforce Peace will prevent the recurrence of war unless mankind by foresight and conservation adapts itself to this irreducible datum.

Argument never could bring the adaptation to pass. Imagination may, since it has begun to picture the true nature of economic cost. Before 1914 we thought in terms of money. To have money was to be rich, for money could buy anything desired. Even credit was economic power. Credit and money are power now, they will continue to be power, but the average man perceives now, as he did not before, that they are

Digitized by Google

power only when and if they actually command material things, and that it is these, and not the money or the credit that are wealth. He sees, too, that it is the using up, the consumption of material things, and not the draft on a bank account, that is elemental cost. The war not only raised prices: it made a lengthening list of things that money could not buy, at any price. It restricted our use of grain and meat; of coal and gasoline. It compelled us to plow up waysides and old pastures, to save cotton and paper, to make bandages and socks. We heard that Germany had melted statues and stripped roofs to eke out her dwindling store of copper. It was a salutary lesson, but like similar lessons in the past it would soon have been forgotten if it had been inflicted on one people only. Inflicted on the whole civilized world it has profoundly impressed imagination. Now the picture is being etched in by the anarchistic destruction of industrial capital and resulting misery. The deeper its lines are cut by these acids of woe, the longer perhaps they will last.

The second instance of revaluation to be named lies in the realm of moral estimates. If what has been said about the reconditioning of instinct and the reassociation of imagination is good psychology, we must conclude that our most evil inheritance from barbarism is not our brutal instincts and our turbulent passions in their native nakedness, but rather the criminal maxim, which has marshalled and directed them, that the end justifies the means. This maxim is of the essence of barbarism, while insistence that means no less than ends must be justifiable and be justified, is the quintessence of civilization.

Barbarism was the effort of the savage to rise above his savagery. He no longer lived on roots and lizards, or, if affluent, on raw fish. He hunted with ingenious weapons, and rudely tilled the ground, or, roaming the grass lands, he had multiplying herds of horses and of cattle. He began to build substantial structures, and to accumulate material possessions. By comparison with the wretchedness from which he had risen his new estate was wealth and power. To hold it against the marauder and to increase it by plunder became his supreme concern. Rude times make hard men. The barbarian knew neither scruple nor ruth. Enough for him that steers and goats could be had for the taking, if their herders could be slain. Enough for him the avenging law of his clan, which protected clansmen but extended no right to the stranger. Only the wrath of his god he feared, and his god was a proto Gott.

Civilization is the effort of the barbarian to rise above his barbarism. The civilized man no longer drinks sour milk by preference from a skin, or always cuts his steaks from bullocks roasted in the open. Disorder

Digitized by Google

and violence no longer profit him; they destroy business and capital. Acquaintance with strangers and aliens has discovered in them unmistakably human traits. It has become expedient to live on good terms with them, and that is most conveniently managed by extending to them the courtesies of urbane intercourse and the protection of law. Fostered by law, ideas of right are clarified. They coalesce, and a notion of justice emerges, which slowly takes shape as it broadens and imagination plays upon it. Then sentiments cluster about it, and when they are traversed resentment and indignation awaken, threatening social order. So justice and good manners become social possessions, jealously cherished, as material possessions are. For private ends individuals must not break the law nor disturb the public peace. They must achieve lawful ends by lawful means and, in good society, by urbane means.

Civilization is old, but unhappily its requirements, not yet perfectly established in practice, are not yet universally acknowledged as binding. And backward peoples are not the disturbing failure. In the most enlightened nations are surly multitudes to whom the tang of barbarism is pleasant. In years of war and days of revolution they give themselves up to primitive vehemence. Their fury then is elemental, and crudely destructive: it becomes sinister when intellectually directed by men who repudiate morality in the name of a higher good, and deny that great causes are bound by due process of law.

Proclaimed by retainers and sycophants the dogma that the king can do no wrong is more irritating than perilous. Argued by a Machiavelli the dictum that princes may treacherously lie for the health of the state may set nations cutting throats on the telegram of a Bismarck. Inculcated as Koran or Kultur the monstrous teaching that Islam or Hundom should spread truth by the sword has annihilated the achievements of generations; and the Bolshevist programme of liberty by bullet and torch will open the gates of the bottomless pit, if we let it.

We shall not let it. The race of man is standing again, as often before, at the parting of ways; but the eyes of the nations are no longer holden. The ends that civilization has set before itself were never so clear, and never so desired; but the means by which men have sought to attain them have been tried in the fires of wrath. We have reappraised their values.

The third revaluation to be named is being made in that realm which somewhat vaguely we call the spiritual. By this word as here used I mean something different from the supernatural and beliefs about it. I conceive of spirituality as a certain sensitiveness, which some men

Digitized by Google

have and some have not to the finer, or subtler, or more elusive good. It is delicacy of apprehension and reaction. For men in whom this sensitiveness exists the word God has always awakened thoughts not necessarily theological, or philosophical even, yet religious. If theistic in belief such men have conceived a God personal and good. If agnostic and not convinced of the existence of any being or power extraneous, or immanent but not ourselves, that can be described as good they yet have apprehended in ourselves and in human history a drive that works righteously, engendering righteousness. Theistic or agnostic they have both conceived a process and constructed a scale of values, and then have associated the dynamic fact most significant for their thought with the highest good that they have apprehended.

Men of a coarser nature have proceeded differently. They have not been interested in any intangible or immaterial good; they have not apprehended it. They have been interested in gold and in power. Their gods have been gods of power—pitiless and stark, laughing to scorn such as have dealt justly and loved mercy.

Christianity, Professor Tyndall said, varies with the nature on which it falls. Taken as he meant them, the words are true. So all religion varies, and so do all ideas of God. We have long been aware how divergent they are and of what unequal value, but we have shrunk from examining and appraising them. Now the duty to revalue is imperative but it has been rendered easy. The worshippers of barbarian gods have fought in France and Flanders and where Islam was, against men who heard a still, small voice speaking to those whose hearts loved mercy and whose souls were sensitive to truth. The days of Allah's sojourn in the West are numbered and Gott is dead.

Digitized by Google

INDUSTRIAL RESEARCH.

BY FRANK B. JEWETT.

MEMBERS OF THE ROYAL CANADIAN INSTITUTE AND GUESTS:

In appearing before a Canadian audience to discuss matters pertaining to the promotion of research and, in particular, to its promotion as related to the industries, I have to confess a lack of that knowledge of conditions in Canada which should be the basis of any constructive consideration of the topic. Fundamentally, the conditions are everywhere much the same but specifically there are great differences which arise in different countries and different parts of the same country because of different educational and industrial needs or because of the different treatment or lack of treatment which the legislative bodies have accorded. In view of my unfamiliarity with the present situation in Canada, I would ask you to consider what I have to say as being the result of my observations in the United States and of being applicable specifically only to the conditions which now obtain there.

When a man is called upon to testify as to facts or opinions it is, I believe, customary for his testimony to be introduced by a statement of facts intended to establish his right to be heard and have an opinion on the matter in hand. Since the matter before us is at present one in which many diverse views may be held and diverse courses of action advocated, it seems to me proper that this judicial custom should be applied in my own case in order that you may have some basis for deciding upon the weight you may wish to attach to any opinion or suggestions which I may make.

Largely through chance, my training and experience have been such as to give me something more than a dilettante's knowledge of four of the fields which are factors in the problem which we are here to discuss. These fields are those of (*a*) so-called scientific or pure research, most largely exemplified in our universities and higher institutions of learning; (*b*) engineering; (*c*) industrial research and (*d*) general business. Trained as an engineer in a technical school having more or less the standard scholastic ideas of the time as to the proper form of engineering education, chance threw me in the way of spending four years at the University of Chicago in physical, mathematical and chemical research under Professor A. A. Michelson, one of the world's greatest living

Digitized by Google

physicists—a Nobel prize winner. This novitiate under the tutelage of a master seeker after truth in the realm of physical science completed, I again took up my engineering profession in the form of graduate study and teaching at the Massachusetts Institute of Technology and had no more than completed this work when chance again threw me back into the research field,—this time on the industrial side and for what appears to be a life pursuit.

For the past fifteen years I have been intimately associated with the research and engineering activities of the Bell Telephone System, first as the Transmission Engineer of the American Telephone and Telegraph Company and for the past seven years as Assistant Chief Engineer and Chief Engineer of the Western Electric Company, Incorporated, which is the research, development and manufacturing part of the Bell System. During this time, which spans nearly the whole of the period of organized industrial research in America, the entire spirit and atmosphere of engineering work in the telephone field has changed from one of inventive experimentation and rule-of-thumb methods to one in which the principles of scientific research govern practically every cou se of action. During this period the research laboratories of the System, which were among the earliest to be established in this country, have grown from one or two back rooms in an old building until they now occupy nearly a half million feet of floor space in a building especially designed for their accommodation. At the same time the staff has grown from one or two trained men to one of a number of thousand trained men and women, a large number of whom are graduates of leading research universities and laboratories throughout the world.

Having attempted to qualify, I will now try to give you a picture of the industrial research situation and its problems as I see it.

It needs no statement from me to apprise you of the fact that research, and particularly industrial research, is very actively in people's minds and before the public at the present time. Newspapers, magazines and periodicals are continually publishing articles on it; vast numbers of people are talking, more or less knowingly, about it; and industries and Governmental Departments, which up to a few years ago had hardly heard of industrial research, are embarking or endeavouring to embark upon the most elaborate research projects. While the conditions which now exist largely through the stimulus of war activities are particularly favourable to a vigorous and healthy growth of both academic and industrial research if properly directed, they are equally favourable to the waste of much human energy and huge sums of money

Digitized by Google

if sanity, clear thinking and a proper sense of proportion in initiative and legislation are neglected.

That much good and enormous advances in the industries of a country will result from a proper application of research methods to their problems cannot be denied by any one who has had experience in this field. It is, I think, equally undeniable however that a very grave danger confronts the industries and the nations in some of the misconceptions of what is involved in industrial research which seem to be prevalent throughout the world at the present time. During the past five years there has been so much talk about the wonderful results to be obtained in the application of industrial research, so much exploitation of what Germany was able to do in this line, and so much exploitation of the extent to which the Allied countries have been able to equal and surpass Germany that grave misconceptions have arisen in educational, industrial and Governmental circles—misconceptions which if not corrected are sure to cause trouble and bring about a reaction which for a time will tend to drag research down from the high place it should occupy in the realm of human affairs.

The results of the research activities throughout the war have been simply astounding, even to men whose whole training and experience have been along this line. Few, however, realize the exact price paid for these results or appreciate fully the reactions on the orderly peace-time life of the nations brought about by the diversion of our educational and research energies toward the one common purpose of human destruction. With the picture of recent scientific war-time achievements before us, it is difficult to realize that in setting up the machinery to accomplish these achievements we at the same time set up the machinery for the destruction of advances beyond a certain point. By robbing the colleges, universities and industries of their trained scientists and employing them in war's scientific sweat-shop, it was inevitable that stupendous results should be obtained. By so doing however we cut off completely the possibility of further advances into the realm of the unknown and likewise destroyed our chance of developing new men to carry on the investigational work of the old, when the latter were worn out.

Had the war continued much longer under the conditions which obtained during its maximum violence, it seems clear that it would have resolved itself into a struggle in which mere mechanical ingenuity would have supplanted everything of a really research nature—this because of the fact that while war stimulates very greatly a clever, inventive in-

Digitized by Google

genuity in men it cannot provide the atmosphere nor surroundings which make for developments in the realm of the unknown. During the war I have derived much pleasure from an intimate personal contact with many of the most prominent scientific men of the allied countries and while they were, even to the end, working effectively there was every evidence that the strain was telling and that their productivity could not be long continued. Further, there was no influx of equally good new men.

While I am not in a position to know the exact situation elsewhere in the world, I do know that we in the United States had early in the summer of 1918 arrived at the state where scientific man-producing machinery no longer existed. Practically all of our investigators and those best competent to develop a new generation of investigators were somewhere in the service, but even if many of them had remained in their laboratories there was no human material for them to develop. The young men of college or university calibre not already in the Army or the Navy were in military training camps or schools where they were being crammed with a smattering of the sciences to render them efficient in the handling of the thousand and one details of a modern military establishment.

But despite all these tangible evidences of the alarming decrease in the essential raw human material, projects were being started daily for the establishment of industrial research laboratories in connection with all manner of civilian and military organizations. The common opinion seemed to be that all that was necessary was to construct a building or buildings, put in some machinery and instruments, gather together a few human beings, label the whole a research laboratory and proceed to "research".

I venture to say that there are possibly ten times as many so-called research laboratories and more than ten times as many so-called research investigators in the United States to-day as there were three years ago and yet during that time practically no real research men have been produced. Every day I meet men or groups of men who have acquired a certain superficial knowledge of research matters and a limited vocabulary of its terms and who talk convincingly of the future of industrial research and of the enormous material benefits to be derived from the extension of this form of activity. They fail utterly to realize that the mere dubbing of a man by some research title does not make him any more a real research investigator than sewing a pair of wings on a tunic makes a man a military aviator. They also fail to realize that even under

Digitized by Google

the most favourable conditions as to human material, the mere getting together of a group of men does not bring a research laboratory into being. Finally, it is clear from the very fact of their being ready to embark upon the project that they do not appreciate that while industrial research, properly organized and carried out with the right kind of human material working in an atmosphere that is sympathetic to industrial research development, has proven enormously valuable, it is under other auspices a sink for money and hopes which is second only to a salted gold mine.

As an ardent advocate and firm believer in the promotion of scientific and industrial research as a means of bettering the condition of our people, I would feel myself derelict in appearing before an audience of this kind if I did not sound a note of warning about the dangers I see and at the same time endeavour to set before you constructively the conclusions which twenty years of active participation in the field of scientific and industrial research have led me to feel are essential to a vigorous and hardy growth of this form of commercial activity.

You will remember that earlier in the paper I mentioned the fact that in fifteen years the scientific research activities of the Bell Telephone System have grown from practically nothing to huge laboratories, with outposts for specific problems in various parts of the United States and even in foreign countries. In addition to being what may be thought an interesting statement of fact, the salient thing to be understood is that the research activities have *grown* and not been formed in any haphazard or over-night fashion. This fact is equally true of every large successful industrial research organization with which I am acquainted. Even to-day and despite the aggregation of human and material resources which have placed our laboratories in the front rank of industrial research organizations, there are on my list a large number of problems which we are not in a position to undertake. These problems, which are directly and solely in the communication field, are problems of major interest to the industry and are of such a nature that we are absolutely sure they can be solved with positive results of inestimable value to the telephone and telegraph companies and to the public at large, provided only that their solution can be obtained through the application of well-organized industrial research. Why then do these problems lie essentially untouched? Is it because of a lack of material facilities, of money, of courage to go ahead, or the feeling that these particular researches will not recommend themselves to the business men who are responsible for the commercial destinies of the telephone and telegraph systems? It is none of these. There is no lack of money, no lack of material

Digitized by Google

facilities, no lack of courage, no lack of approval on the part of directors, for we have long ago learned that material facilities are easy to obtain, that money spent in properly-directed fundamental research, large though the sums may be, is small in comparison with the direct and indirect returns, and finally that apparent courage in deciding to go ahead is not so very courageous after all when it is exercised by men of ability, training and experience who have shown themselves competent in their own fields, whether those fields be within the laboratories or within the precincts of the executive offices.

What then is it that should stop us from an immediate attack if we are so sure of the ultimate result? The answer is the simple, three-letter word "men". Not mere human male bipeds but men endowed by nature with at least a modicum of the spirit of scientific research to which has been added, either through fortune, personal initiative, parental solicitude or a far-sighted policy on the part of the State, that orderly training and opportunity for expansion of intellect without which natural talents are of little avail.

Our case is typical of the situation which confronts every industrial research organization on the continent. The matter of an adequate supply of properly-equipped and trained investigators and directors of research is absolutely vital to the growth of industrial research and I am as sure as one can be of anything in the world that all of our visions of the benefits to be derived from a large expansion of industrial research will come to naught if we fail to realize or neglect the fact that in the last analysis we are dependent absolutely upon the mental productivity of men, and men alone, and that we must in consequence provide adequately for a continuous supply of well-trained workers.

While there is at the present time some diversity of opinion among the directors of industrial research as to the proper methods to be followed in an industrial research laboratory, there is unanimity on the point that industrial research organizations are essentially man-consuming as distinguished from man-producing agencies. The very fact that they are industrial and commercial in nature means that in the aggregate the performance of industrial research laboratories must be money making rather than money consuming if they are to continue to exist. For this reason they cannot assemble a staff of investigators to each of whom is given a perfectly free hand with regard to the scope and character of his work. There is unquestionably some ground for debate as to the extent to which it may be desirable to go in permitting or even stimulating individual workers in an industrial research laboratory to

Digitized by Google

undertake the investigation of problems not directly involved in the interests of the company or business of which the laboratory is a part. Personal equation, the relation of any particular laboratory to outside interests and numerous other factors all enter to prevent the formulation of any hard and fast rule in this matter. To me it is self-evident, however, that the great bulk of the work in any industrial research laboratory must be intimately along the lines of the business with which it is associated and must be mainly of a utilitarian character with results measurable by economic standards rather than purely scientific or educational with results measured in terms of increased general knowledge or the production of trained men.

I have said that all of us who have had any considerable experience in this field seem to be a unit as to the necessity for stimulating and maintaining proper sources of supply of our trained workers.

There is, however, not the same unanimity with regard to the best method to be employed for bringing about the desired result. At the present time the conditions are sufficiently formative and undeveloped so that many suggestions and schemes can be made. A good many men who have had broad experience in the development of industrial research feel that the best results will in the long run be obtained by fostering a trial of almost any suggestion which is not an obviously foolish one—this on the theory that by so doing we will accumulate rapidly the data and experience from which definite conclusions can be crystallized. Others, and I am one of this number, feel that the information now available is sufficient to permit of drawing certain conclusions and concentrating our efforts on the trial on a large scale of a limited number of experiments in the directions which seem to give most promise of producing the requisite number and kind of trained investigators to meet the increasing needs of industry.

From whatever point we view the problem it seems clear that the agency for producing the trained investigator must be outside and distinct from the industrial research field. It seems reasonably clear also that this agency must be in some way intimately associated with the field of so-called pure scientific research, that is, the form of research intended primarily to extend the bounds of human knowledge as distinguished from that form of research intended primarily to attain a certain desirable objective through the application of scientific research methods. Two courses only appear promising:

Digitized by Google

1. The establishment of a limited number of large research laboratories which are endowed either by the State or other private or corporate munificence, or
2. The stimulation of scientific research in a more diverse fashion through the universities and higher educational institutions.

Under the first of these plans the institutions, in addition to their work of extending the bounds of human knowledge through scientific research, would serve as a sort of finishing school for the training of men who have already received a general scientific education elsewhere and who are destined ultimately to engage either in the type of research carried on in such institutions or more largely in the field of industrial research. The success of this plan on a scale adequate to the needs of the State would appear to involve a concentration at the limited number of research institutions of practically all of the country's leading scientists qualified to engage in fundamental research or in the proper instruction of men for the industrial field. This would tend largely to deprive the colleges and universities of the services of all the men with a research trend of mind and leave them with an atmosphere wholly pedagogical in character. Far more serious than the mere absence from the university faculty of the advanced thinkers, would be the fact that such absence would bring about a condition in which there is nothing to stimulate properly qualified young men to take up scientific research as a life pursuit. Also such concentration of fundamental research in a limited number of large endowed institutions would, I think, tend inevitably to diminish rather than increase the wide-spread feeling that the progress of the country was intimately associated with the healthy and vigorous growth of scientific research.

Considerations such as these tend toward an adoption of the second alternative, which is a delegation to the properly qualified universities and institutions of higher education of the duty of training the men who are later to carry on the industrial research of the country. Such a plan does not and should not contemplate making every so-called university or college a centre of research. Financial and legislative assistance, of whatever form, should be reserved for those institutions which are equipped or can be equipped with the necessary men and facilities for carrying on properly the work of research and training. In order that the spirit of research and the direct benefits which accrue from it should become generally known, the institutions which are chosen for carrying on this work should, so far as possible, be located where they can draw from the best elements of the population and where their work will be

Digitized by Google

under the immediate scrutiny of the citizens. While energies should not be scattered through diffuse grants of aid, no stone should be left unturned to stimulate the growth of a research atmosphere in any institution which can by any chance aspire to qualify as a centre.

In the United States the direction of efforts tending to promote the progress of fundamental and industrial research and the training of properly qualified men is centering in the National Research Council. This body, which is composed of the leading scientific men of the country from all branches of science and from all of the activities, both civil, military, educational and commercial, was formed in the summer of 1916 by the National Academy of Sciences at the request of the President. Because of the fact that the National Academy of Sciences is the only nationally chartered scientific body and because of the further fact that the President has by proclamation empowered the National Research Council to undertake certain broad duties, it is the agency best qualified to handle the complex problem which is to confront us in the years to come.

During the war the efforts of the National Research Council were, of course, directed to the immediate problems in hand but with the signing of the armistice and the cessation of hostilities broad peace-time plans which had lain dormant were taken up anew, and, with some modifications over the arrangements initially contemplated, the National Research Council is actively at work on plans which bid fair to produce extremely beneficial results. The fact that the Council is composed of the leading men of the country, who are interested in research and the results of its commercial application and who are personally active in the affairs of the Council, makes for the attainment of positive constructive results not otherwise to be hoped for.

Two main problems are at present before the Council. One of these is the organization of the proper means for promoting fundamental research on a high standard of achievement and the correlated problem of training a sufficient number of properly selected men. The other problem is that of promoting the interests of industrial research.

In considering these two activities of the National Research Council it should be understood that the work of the Council is purely in the direction of formulating general policies, correlating and concentrating efforts in any desired direction, and acting as a general clearing house and advisory body for the multifarious research activities of the country. The plans at present under discussion do not contemplate having the Research Council as a whole attempt to undertake or supervise specific research

Digitized by Google

work, except as such specific undertaking or supervision may from time to time be found advisable in carrying on the work of the component divisions. In the carrying on of its functions as at present proposed, each general activity will be in the hands of a special group whose primary interest is in that particular field. Thus, for example, the group in the National Research Council which is interested in the relations of the Council to engineering and the applications of industrial research to engineering will be, in effect, a group principally of and from the great national engineering societies and under the direct supervision of their governing boards.

Both of the alternative schemes noted above for handling the matter of fundamental research and training have been carefully considered, with the result that at the present time the trend of opinion in the National Research Council seems to be toward that arrangement which utilizes the existing educational facilities of the country as against the centralized research laboratory idea. This decision does not, of course, mean necessarily the abandonment of the idea of further large fundamental research organizations, such as the Rockefeller Institute, but it does mean that at the present time there is a feeling that such institutions should be looked upon as a means for the attainment of a specific end rather than as part of a nation-wide machine.

The plan now actively under consideration and which is of most interest to those engaged in industrial research contemplates the establishment of a number of well-paid research professorships in Physics and Chemistry in as many of the leading universities as can qualify for the proper carrying on of the work. These professorships, if established, would require that the holder devote the major part of his time to the carrying on or direction of research work and that but a limited part of his time be allotted to teaching. In addition to these research professorships, the plan contemplates the provision of research fellowships in Physics and Chemistry, to be awarded for a period of years not to exceed five, to men who have shown themselves fitted for such fellowships. As the requirements for fellowship award would tend toward the selection of mature men as distinguished from those but recently graduated, the plan provides for a fellowship emolument sufficiently high so that the recipient, even if married and with a family, would be in a position to accept and devote his entire time to research investigation, save only a limited amount of time which he might be encouraged to devote to the instruction of younger research men.

Digitized by Google

While it is as yet too early to predict how this plan will finally work out, it seems reasonably certain that the necessary funds for the research fellowships will be available. The main question appears to be whether the qualified universities will in all cases be able to provide the funds necessary for the research professorships and more particularly with regard to the number of men of research professorship grade who are actually available. There can be little doubt but that the successful working out of some such plan as this would be of very great value to the industries and the cause of industrial research. It would introduce the spirit of research into the universities on a plane far higher than it has hitherto occupied in America and by so doing would react in a stimulative way on the younger men in the university or college—a group from which the future fundamental and industrial research workers must come. The fact that many of the research fellowships would be held by men who had made a mark for themselves in industrial research would make concrete the fact that fundamental research and a Doctor of Philosophy degree can lead to something other than a pedagogical career, an impression which I am sorry to say has been the prevailing one in America for many years.

That the industries of the United States are more than casually interested in the work which the National Research Council is undertaking is evidenced by the fact that already large sums of money have been contributed by corporations, industries, and individuals toward the carrying on of the work of the Council. For example, to cite a case with which I am personally familiar, the American Telephone and Telegraph Company has recently appropriated $25,000 a year for a period of five years to be used by the National Research Council in its work of promoting industrial research in the United States and in educating business organizations to the benefits to be derived from it. This is but one of numerous tangible evidences that industries which have eaten of the fruit of a real industrial research department pronounce it good and are desirous of stimulating a further and larger consumption of the same fruit.

It may seem to you that in the foregoing I have gone rather far afield from the subject matter of industrial research and its promotion and application and have emphasized too strongly the fundamental research and training aspects of the problem. My reasons for this have been twofold; first, because there is a very large and rapidly-growing appreciation among industrial research workers of the fact that this phase of the matter is of vital importance to them, an appreciation of the fact that if the

Digitized by Google

fundamentals are not properly handled industrial research can have but a limited growth, whereas if the supply of capable trained men is adequate and the field of fundamental research properly cultivated many of the problems of industrial research itself which now appear difficult of solution will, in a large measure, take care of themselves. In the second place, it seemed to me that as this appreciation is not local to any country or any section, a statement of the present situation in the United States with regard to the methods and plans now under way might be of some interest in Canada. Whether this is so or whether the exact arrangement of any scheme which we south of the border may work out will be applicable to Canadian conditions, I am, of course, in no position to say.

I will not here attempt any long discussion of the best methods for handling industrial research, once a supply of properly-trained investigators is assured. There was a time when the proposition of having the colleges, universities and technical schools undertake industrial research on a very large scale was much discussed. Recently such discussion has diminished, largely through a clearer understanding of the requirements for successful industrial research and also, I think, because of a better appreciation of the direction in which the research energies of the universities can be most effectively directed for the advancement of industrial research.

Then too there has been much discussion on the proposition of specialized research organizations maintained by companies or collectively by industries versus large centralized industrial research laboratories, either Governmental or private, to which all sorts of industrial research problems can be brought for solution. While I do not know what a study of the conditions in Canada, with its more sparsely settled and less developed industries, might lead me to conclude, I think that in the United States these questions are in a fair way to solve themselves. With us we have a condition of great centralized industries, such as the electrical manufacturing companies, the telephone and telegraph systems, the steel and oil industries and others of the same class, each one of which is of sufficient size to maintain adequately a large and well-rounded-out research organization competent to handle any of the numerous problems which present themselves. Next, we have a large group of industries, the individual units of which are of considerable size but not sufficiently large to justify the complete research staff which might be needed to cover all of the problems. For this class the tendency seems to be toward an association of the different units for the general support of a research organization available to all of the industries and to which will

Digitized by Google

go all of those problems which are of general interest to the industry as a whole. Finally, there is a great mass of small industries and businesses, no one of which could hope to maintain a research organization and which are too small and too widely scattered to permit readily of associated efforts such as those just outlined. It is essential, however, that each one of these smaller industries be accorded the advantages which accrue from a proper solution of their problems. It is my feeling that the needs of this industrial class are likely to be met through the establishment of commercial research organizations rather widely distributed over the country and tending at some general degree to a specialization of effort. To these organizations the individual industries can bring their problems for solution, much in the same way as they now go to consulting engineers for advice. It is, of course, conceivable that this service might be rendered by a Government-supported research organization with one or many laboratories. There are large difficulties in such a plan, however, principal among which would be the difficulty of maintaining as high a standard of scientific and technical ability as could be maintained in a non-Governmental organization.

But whatever the final solution with regard to the care of the smaller industries, it is absolutely certain that the big industrial units, or the aggregation of units of the second class, will tend to make little or no use of the outside laboratory, be it private or Governmental. Their problems are so large and so intimately connected with the intricacies of their business that it is difficult to see how they could have the work carried on by an outside organization without, in effect, making that organization a part of the industry.

In conclusion, I should like to present for your consideration a few points which I think are fundamental to the successful carrying out of any broad policy of industrial research growth within a nation and a few other points which my experience has taught me to look upon as beacons in the course of building up an effective and smooth-running industrial research organization. The points of the general problem which I would make are:

1. That no extensive and successful industrial research growth can be looked for unless provision is made for a continuous supply of competent men of broad general training and a specific and thorough training in the methods of scientific research.

2. That coincident with the growth of real industrial research there must be a corresponding and equal growth and development in the domain of fundamental scientific research which will broaden the bounds

Digitized by Google

of knowledge and open up new avenues for the industrial research worker.

3. That there must be education to develop a full understanding of the material and economic advantages which will result from the supplanting of the purely cut-and-try inventive type of growth by the application of scientific research methods and the further knowledge that a vigorous and healthy growth of fundamental scientific research is an integral and absolutely necessary part of the problem. In the one case this education must be directed toward the industrial interests for the purpose of indicating to them the advantages to be gained by an abandonment of methods which are not in accord with the present-day state of world-knowledge and the building up of a demand for the right type of men, and in the other case toward the population at large for the purpose of instilling an appreciation of the advantages which will accrue to the nation and attracting to the field of research, whether fundamental or industrial, a larger proportion of qualified men; also for the purpose of having the people at large view with sympathy a reasonable allotment of general funds for the advancement of research activities.

4. That a realization of all of the foregoing can best be obtained by a close co-operation between the industrial and business interests of the country and the higher educational institutions, which are already looked upon with favour by educated and thinking people, and from which must come the men qualified to build up industrial research.

5. That whatever the scheme finally adopted to provide for an expansion in the domain of fundamental research and the development of competent industrial research workers, care must be taken to insure that pressure from the industries will never be so great as to withdraw those men who can render the greatest service by continuing as investigators in the field of pure research and the training of younger men. Such a course would be suicidal if long continued and I mention the point because of the fact that my experience indicates a considerable tendency on the part of industries which have benefited from industrial research to endeavour to attract into their service the best of the university research men. I confess that the temptation to do this is very great and that the monetary inducements which industry can offer to the individual are large and not easily to be withstood by a man whose normal human reaction is for the material welfare of his family.

Finally, as to those specific points which may be of interest to anyone endeavouring to build up an industrial organization:

Digitized by Google

1. The research department must be so organized, developed and equipped with men and machinery that the net result, direct or indirect, will be of decided monetary value to the industry. Otherwise, it has no reason to be.

2. The present state of the art is such that a large number of the problems falling within the field of the industrial research laboratory are inherently expensive. For this reason, while enormous returns may be possible from the successful completion of any line of research, lack of success or an attempt to conduct it with inefficient help will mean the waste of much valuable time and money. For these reasons the choice of the staff and the careful consideration of all of the factors in any problem are of the utmost importance.

3. That successful industrial research under modern conditions is essentially one of organization and group working, as distinguished from the essentially individualistic work of fundamental research. For this reason extreme care must be taken to secure competent executives, either from the ranks of those whose primary training has been along research lines and who have shown capacity for handling men and complicated problems or from those of executive capacity and experience who have shown a proper sympathy for the requirements of research.

4. That all industry tends to be conservative and that great care must be taken not to attempt the forced growth of a broad industrial research development where a too rapid growth will engender the active opposition of those who have been educated in a different environment. My experience has indicated that there is never any trouble where the proper method is employed but that there is always trouble if the so-called practical man feels that the proposed new methods are essentially a reflection on his ability and that his point of view is not receiving sufficient consideration. As a matter of fact, the practical man's point of view and his knowledge, gained by long experience, will be found to be one of the chief assets of the successful industrial research worker.

5. That some industries are much more conservative in their attitude toward the adoption of modern research methods than others. In general, I think it will be found that the most conservative are the oldest and are those industries which existed long before the science of their art had been developed. Because of the fact that modern electrical and chemical industries have grown directly from pure scientific developments, I think they will be found to be easier fields for the cultivation of industrial research than older industries, such as those which were well developed in the earlier periods of human affairs.

Digitized by Google

6. Finally, a most important point, not to be lost sight of in the organization of a successful industrial research department, is the fact that many very capable men trained for industrial research are essentially devoid of certain commercial attributes. Many of them, for instance, fail to realize that on a large number of their problems time is an essential element in the work, while others fail to give due weight to that phase of the work which lies between the completion of the research activity and the introduction of the results into commercial manufacture or employment under modern conditions where the day-by-day control must, of necessity, be largely in the hands of those who are not highly-trained skilled workers. For this reason it is essential that whoever is responsible for the direction and success of the industrial research undertaking should be a man with a broad outlook, a full appreciation of all of the factors of the business problem and a man who can sympathize with and appreciate the varying points of view which he encounters and who can harmonize all of the activities into a smooth-working machine.

In closing I wish merely to go on record with you by saying that after many years of experience, I now, as an executive in a large technical organization, am more than ever a firm believer in the benefits to be derived from a vigorous stimulation of both fundamental and industrial research, benefits which I believe will accrue not only to individual industries but to the people at large as well. It seems to me that, provided we have proper legislation to safeguard a just distribution of the benefits, we have in industrial research a most valuable means for ameliorating and bettering the conditions of mankind.

Digitized by Google

Digitized by Google

OFFICERS

OF

The Royal Canadian Institute

1918-19

President

J. MURRAY CLARK, M.A., LL.B., K.C.

1st Vice-President	2nd Vice-President
PROF. J. C. FIELDS, PH.D., F.R S.	G. H. LOCKE, B.PAED.

Secretary	PROF. H. F. DAWES, PH.D.
Treasurer	W. B. TINDALL, ESQ.
Editor	PROF. J. H. FAULL,, PH.D.
Librarian	PROF. D. R. KEYS, M.A.
Curator	H. JEWELL, ESQ.

Members of Council

PROF. J. C. McLENNAN, PH.D., F.R.S.
SIR FREDERIC STUPART
PROF. J. J. MACKENZIE, B.A., M.D.
J. B. TYRRELL, M.A.
PROF. C. D. HOWE, PH.D.
F. ARNOLDI, K.C.
PROF. J. P. McMURRICH, PH.D., LL.D.
J. PATTERSON, M.A.
THOS. RODEN, ESQ.
PROF. A. G. HUNTSMAN, M.B.
LT.-COL. A. FRASER, LL.D.

Digitized by Google

Lithomount
Pamphlet
Binders
Gaylord Bros. Inc.
Makers
Syracuse, N. Y.

UNIVERSITY OF MICHIGAN
3 9015 08112 7873

Museums

Digitized by Google

Digitized by Google